

**SAFE ENGINEERING AND OPERATIONS
(SEAOPS)**

**LCAC CARGO LOADING
MANUAL**



THIS MANUAL SUPERSEDES SEAOPS VOLUME NO. IV/PART I , REVISION 1, CHANGE D, DATED 1 JUNE 1999

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DEPARTMENT OF THE NAVY

ASSAULT CRAFT UNIT FOUR
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From: Commanding Officer, Assault Craft Unit FOUR

Subj: PROMULGATION OF LANDING CRAFT, AIR CUSHION (LCAC)
SAFE ENGINEERING AND OPERATIONS (SEAOPS) VOLUME IV,
PART 1, REVISION 2

Ref: (a) SEAOPS Manual for LCAC, Volume IV, Part 1, Revision 1,
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Encl: (1) SEAOPS Manual for LCAC, Volume IV, Part 1, Revision 2
Of 6 Oct 00

1. Assault Craft Unit FOUR is the SEAOPS Model Manager and Executive Agent for the SEAOPS Program. This letter promulgates enclosure (1) as Revision 2 to reference (a). Enclosure (1) was reviewed by the Fleet and approved during the 11-13 April 2000 SEAOPS Review Conference held at Coastal Systems Station, Panama City, FL.

2. SEAOPS Volume IV, Part 1, Revision 2 is the authoritative document for all LCAC operating procedures. Procedures contained therein are applicable to all personnel involved in LCAC operations and training.


N. L. HACKNEY

Subj: PROMULGATION OF LANDING CRAFT, AIR CUSHION (LCAC) SAFE
ENGINEERING AND OPERATIONS (SEAOPS) VOLUME IV, PART 1,
REVISION 2

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FOREWORD

SEAOPS manuals are issued by authority of Chief of Naval Operations (CNO) and under direction of Commander, Naval Sea Systems Command (COMNAVSEASYS COM). These manuals are basic manuals for LCAC operations and training. They contain information on craft systems, operating procedures, emergency and casualty control procedures, standards, training and administration, cargo handling, performance data, well deck ship operations, alternate missions, and mission planning required for safe and effective LCAC operations and training.

Currently, the manuals in the SEAOPS series are:

- Volume I - Safe Engineering and Operations (SEAOPS) Manual for Landing Craft, Air Cushion (LCAC)
- OCP - SEAOPS Operation and Casualty Procedures (OCP) for LCAC
- MPC - SEAOPS Mission Preparation Checklist (MPC) for LCAC
- Volume II- SEAOPS Manual for LCAC Standards, Training and Administration
- Volume III - SEAOPS Manual for Well Deck Operations
- Volume IV, Part 1 - SEAOPS LCAC Cargo Loading Manual
- Volume IV, Part 2 - SEAOPS Vehicle Loading Pocket Handbook
- Volume V - SEAOPS Manual for LCAC Mission Planning
- Volume VI - SEAOPS Manual for LCAC Alternate Missions

SEAOPS manuals are LCAC operating standards; however, by themselves, the manuals are not a substitute for common sense and good judgment. A rapidly changing emergency condition or a situation affecting life or property will require ship and craft crewmembers to promptly apply common sense and good judgment.

Each LCAC crewmember is responsible for being completely knowledgeable of appropriate manuals. They shall be studied from cover to cover as a foundation for safe LCAC operations.

This manual (SEAOPS Vol IV, Part 1) is structured in the following manner:

- Chapter 1 - Introduction
- Chapter 2 - Description of LCAC Features
- Chapter 3 - LCAC Configuration
- Chapter 4 - General Procedures
- Chapter 5 - Specific Procedures
- Appendix A - Technical Manual Deficiency/Evaluation Report (TMDER)

This manual provides all information necessary for LCAC cargo loading, restraining and off-loading. It also provides procedures for determining cargo Center of Gravity (CG) and placement, and methods for determining restraint requirements. LCAC Loadmasters, Craftmasters, and personnel involved in mission planning must have a complete understanding of this manual to successfully conduct amphibious missions.

It is accepted that operational or test requirements may require waiver of SEAOPS parameters or procedures. Operational commands, whether ACU or ship, shall submit specific waiver requests to the waiver granting authority as set forth in Appendix H of SEAOPS Volume II. The period that the waiver is to be in effect shall be contained in each request. Each waiver request should address a separate subject. Commands conducting test and trials shall submit specific waiver requests to the Commander, Naval Sea Systems Command, following the same guidance. Each request should be treated as a new entity, avoiding the establishment of precedents and processed in a timely manner.

The following definitions apply to WARNINGS, CAUTIONS, and NOTES found throughout the manual:

WARNING

An operating procedure, practice, condition, statement, etc., which, if not strictly observed, could result in injury to or death of personnel.

CAUTION

An operating procedure, practice, condition, statement, etc., which, if not strictly observed, could result in damage to, or destruction of equipment, or loss of mission effectiveness.

NOTE

An essential operating procedure, condition or statement, which must be highlighted.

In this manual "shall", "will", "should", and "may" are used as follows:

- "shall" - to express a binding provision
- "should" and "may" - to state nonmandatory provision
- "will" - to express a declaration of purpose or to state futurity

Ships, training activities, supply points, depots, naval shipyards, and Supervisors of Shipbuilding (SUPSHIPS) are requested to provide maximum practical use and evaluation of NAVSEA technical manuals. Errors, omissions, discrepancies, and suggestions for improvement to SEAOPS manuals and CD ROM shall be reported via the TMDER form provided in Appendix A of this manual.

1. SEAOPS MANUAL FEEDBACK SYSTEM

- a. The purpose of recommended changes is to increase LCAC operational effectiveness and combat readiness, or to improve operational safety. Feedback should be submitted to recommend revisions to procedures in SEAOPS manuals or to correct document errors.
- b. Feedback identifying discrepancies or conflicts between training and operational procedures noted in SEAOPS manuals and other documentation should be submitted only when SEAOPS

manuals are suspected to be in error. Feedback on other documentation should be submitted via appropriate feedback system.

2. **URGENT FEEDBACK**

Urgent feedback identifies and recommends corrections to technical discrepancies or operational procedures that could lead to equipment damage or injury to personnel. This category is established to provide rapid resolution of suspected SEAOPS discrepancies.

2.1. **Urgent Feedback Preparation** Urgent feedback shall be submitted by priority message to SEAOPS Model Manager (either ACU Four or Five) and the following action addressess: PEO EXW Washington DC//PMS377// COMNAVSURFLANT Norfolk VA//N4/N5// COMNAVSURFPAC San Diego CA//N4/N4312B// NAVSURFWARCEN COASTSYSTA Panama City FL//A41/A42// COMPHIBGRU ONE//N3/N4// COMPHIBGRU TWO//N3/N4/N76// COMPHIBGRU THREE//N3/N4// COMPHIBRON ELEVEN//N3/N4// COMNAVBEACHGRU TWO//N3/N8// COMNAVBEACHGRU ONE//N3/N8/N81A/N81C// ACU FOUR*// ACU FIVE* // ACU FIVE DET WESTPAC ALFA// NAVSHIPYD Puget Sound Det Boston MA//280// EWTGLANT Norfolk VA//N2/N7// EWTGPAC San Diego CA//N7. Feedback shall contain:

- a. A feedback number consisting of year and two digit sequential number based upon the number of urgent feedbacks submitted that year by the originating activity
- b. SEAOPS volume, page, and paragraph number
- c. A detailed description of the problem, justification for proposed change, and any documentation references
- d. Recommended revised text.

2.2. **Urgent Change Processing** Urgent feedbacks will be processed as follows:

- a. Message recipients shall submit comments, if warranted, to SEAOPS Model Manager within three working days. Negative response is not required, and response may be by any means.
- b. SEAOPS Model Manager shall issue advance change notice by Naval Message to addressees per Paragraph 2.1., normally within five (5) working days of receipt.
- c. The advance change will be incorporated into the normal SEAOPS Review Conference as an agenda item.

3. **ROUTINE FEEDBACK**

Routine feedback describes change recommendations that do not meet the definition of "urgent". SEAOPS Model Manager may elect to upgrade routine feedback to urgent and to process related recommendations as outlined in Paragraph 2.2..

3.1. **Routine Feedback Preparation** Routine feedback will be submitted to SEAOPS Model Manager, via submitting activity's chain of command, using a TMDER contained in the last appendix of each SEAOPS manual. Each revision requested requires a separate form. Rearranging several steps in a

*To the unit not currently the SEAOPS Model Manager.

document because of a single technical change counts as one revision. Feedback must be as clear as possible and provide, as a minimum, the following:

- a. Identification of the location of the problem in SEAOPS document (volume, chapter, page, paragraph, table, figure, foldout).
- b. Description of problem and justification reference for change where applicable. A copy of reference pages that support the recommendation should be provided.
- c. Exact wording of recommended solution.
- d. In signature blocks, indicate the person who would serve as best point of contact with an asterisk (*). Ensure that the name is legible and include a phone number when possible.

3.2. Routine Feedback Processing Routine feedback shall be retained by SEAOPS Model Manager and presented as agenda items at the next SEAOPS Review Conference.

3.3. Advance Changes Advance changes to SEAOPS manuals shall be reviewed and acted upon at the next SEAOPS Review Conference and approved by Director, Expeditionary Warfare.

4. INCORPORATION OF CHANGES

Revisions and changes are distributed to holders of SEAOPS manuals.

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CHAPTER 1

INTRODUCTION

1-1. **PURPOSE**

The purpose of this manual is to provide cargo handling personnel with sufficient information and data to load, restrain, and offload all types of cargo efficiently and safely and to explain the restrictions governing these operations. This manual is a two-part document consisting of a general manual for Landing Craft, Air Cushion (LCAC) Cargo Loading, Part 1, and a Vehicle Loading Pocket Handbook, Part 2, that provides reference material for vehicle loading.

1-2. **SCOPE**

The manual contains descriptions, physical characteristics of the LCAC, and cargo handling equipment. Complete instructions are included for loading and offloading pertaining to various types of cargo transported on the LCAC. Restrictions based upon structural strength of the LCAC, and weight and balance, control the amount and placement of cargo. The restrictions shall be complied with to ensure the safety of the LCAC and crew.

1-3. **USE OF THE MANUAL**

This manual is prepared for use by loadmasters and cargo handling personnel. It provides information which will enable them to do their work safely and efficiently. Information is presented in the sequence in which it is likely to be required for use.

1-4. **ARRANGEMENT OF THE MANUAL**

The manual is divided into five chapters.

- Chapter 1 - Introduction
 - Chapter 2 - Description of the LCAC Features
 - Chapter 3 - LCAC Configuration
 - Chapter 4 - General Procedures
 - Chapter 5 - Specific Procedures
-
- a. Chapter 1 - Introduction. This chapter presents the purpose, scope, use of manual, arrangement of the manual, and description of the LCAC.
 - b. Chapter 2 - Description of LCAC Features. This chapter presents a general description of the LCAC and its cargo compartment, including its profile, loading capabilities, ramp systems, cargo deck, tiedown fittings, seat and litter provisions, crew communications, safety, and use and storage of cargo handling equipment.
 - c. Chapter 3 - LCAC Configuration. This chapter presents LCAC preparation instructions with respect to cargo and personnel loading.

- d. Chapter 4 - General Procedures. This chapter contains instructions relative to load planning loading, cargo restraint, and offloading procedures.
- e. Chapter 5 - Specific Procedures. This chapter contains information on cargo items that require special handling or procedures to load, restrain, offload or launch.

1-5. **CHANGE SYMBOLS**

Revised text is indicated by a black vertical line in either margin of the page. The change symbol shows where there has been a change. The change might be material added or information restated. A change symbol in the margin by the chapter number and title indicates a new or completely revised chapter.

1-6. **DESCRIPTION OF LCAC**

The LCAC are built by Textron Marine Systems, of New Orleans, Louisiana, and Avondale Gulfport Marine of Gulfport Mississippi. The primary mission of the LCAC is to transport cargo, equipment and personnel from ship to shore during amphibious operations. The LCAC is capable of transporting a normal load of 120,000 pounds in significant wave height (SWH) of 3.5 to 5 feet. The cargo consists mostly of wheeled vehicles and tracked vehicles up to and including the M1A1 main battle tank. Most cargo is loaded through either the bow ramp or the stern ramp. Up to 23 personnel can be transported in the cabin modules (16 port and 7 starboard). Additionally, a limited number of personnel can be transported in armored vehicles.

CHAPTER 2

DESCRIPTION OF LCAC FEATURES

2-1. GENERAL

All LCACs have the same configuration for transporting cargo and passengers. The location of the center of gravity (CG) varies slightly from craft to craft. Specific location for each craft CG is being maintained in craft maintenance records.

2-2. CARGO DECK AREA

The LCAC cargo compartment extends from frame 1 through frame 19 as shown in Figure 2-1. The design dimensions are 27 feet wide, from frame 1 to 4 feet aft of frame 16, by 67 feet long plus the remainder of the aft ramp area which is 14 feet 10 inches wide by 10 feet 9 inches long as shown in Figure 2-1. Out of a total length of over 78 feet only 49 feet 9 inches of the cargo deck is level. The level area starts at frame 4 and ends at frame 16. Forward of the level cargo deck, the deck is sloped 7 degrees beginning at frame 4 to frame 3 then 14 degrees to the bow ramp as shown in Figure 2-2. The rear deck area is sloped at 7 degrees beginning frame 16 and then to 12 degrees from frame 17 to the stern ramp as shown in Figure 2-2. Both the bow and stern ramps are lowered and raised by electrically operated hydraulic cable winches and can be lowered to a maximum 22 degrees angle.

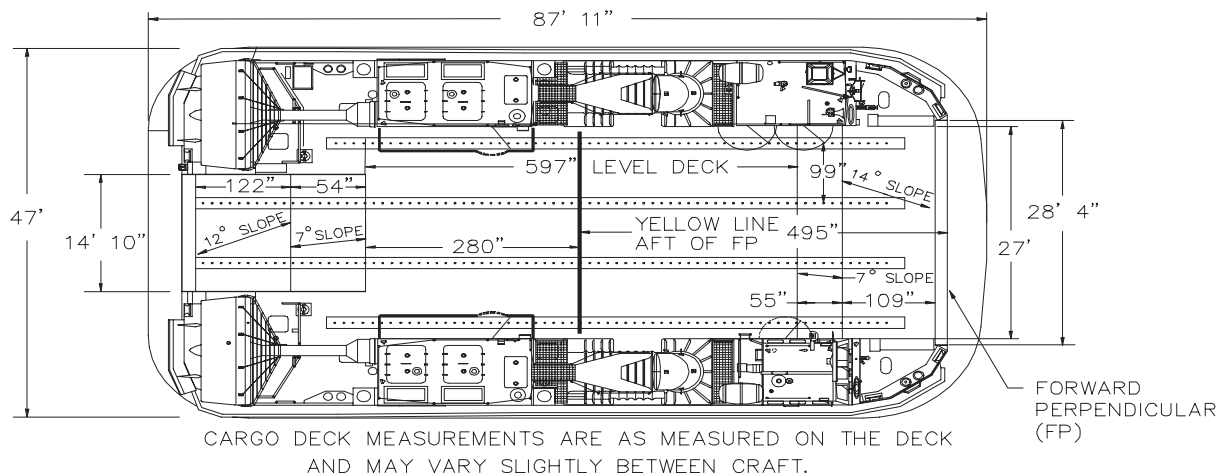


Figure 2-1 Cargo Deck with Dimensions

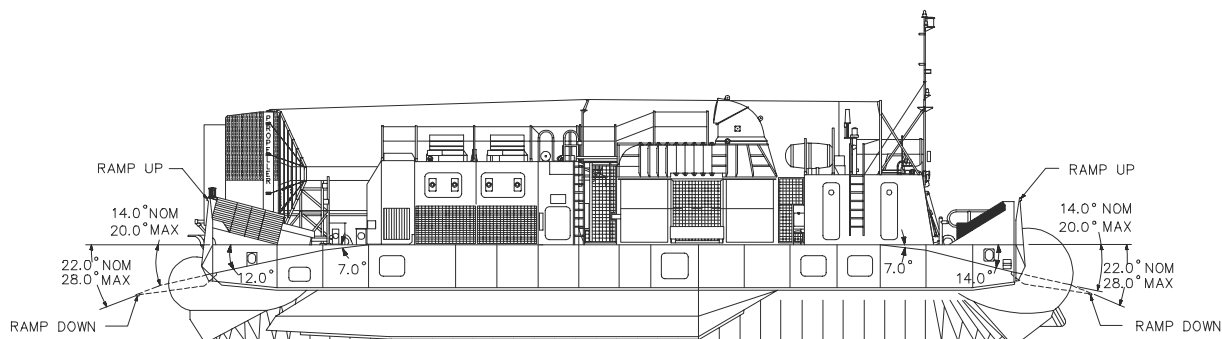


Figure 2-2 Cargo Deck Side View

2-3. **CARGO DECK AND RAMPS**

The LCAC cargo deck has approximately 1969 square feet and accommodates all combat and combat support equipment currently in the Marine Corps inventory. It is constructed of 3/8-inch aluminum plate with internal longitudinal tee stiffeners spaced every 9 inches, and athwartships framing every 4 feet. Four tiedown rails run the length of the deck. The rails are constructed of extruded aluminum sections welded flush with the deck. Tiedown sockets, 2 inches in diameter, are located on each rail. Stainless steel inserts in the sockets accept a standard grab hook assembly. Socket horizontal and longitudinal pull angles range from 15 to 80 degrees from horizontal. To aid in cargo positioning, a yellow athwartship line designating the geographical center is painted across the cargo deck at station 495 inches. Hash marks are painted 10 feet apart on the tiedown rails fore and aft from this athwartship line. A yellow longitudinal line is painted on the craft centerline for the same reason. Figure 2-1 shows the arrangement of the tiedown rails and deck markings. The semi-circles and dotted lines delineate areas of the cargo deck which should normally be kept clear to allow access to command, passenger, and engine modules and the flow of combustion air to the engines. Cargo in the vicinity of the main engine air inlets must be positioned at least 12 inches from the engine module bulkhead in order to ensure that sufficient air is available to the engines.

The bow ramp, 28 feet 4 inches wide by 8 feet 6 inches high, and the stern ramp, 14 feet 10 inches wide by 8 feet 6 inches high, both are operated by hydraulic cable winches, two for the bow and one for the stern ramp. These ramps are hinged at the base and open downward to provide a ground to craft interface.

2-3.1. Strength Limits The cargo deck load limitations are as shown in Figure 2-3. The areas near the center rails have additional strengthening for support of tracked vehicles and other vehicles with a gross weight over 50,000 pounds. Bow and stern ramps are capable of withstanding all cargo loads provided the ramp is extended to the ground position prior to loading. For specific limitations for the craft and cargo deck, refer to Table 2-1.

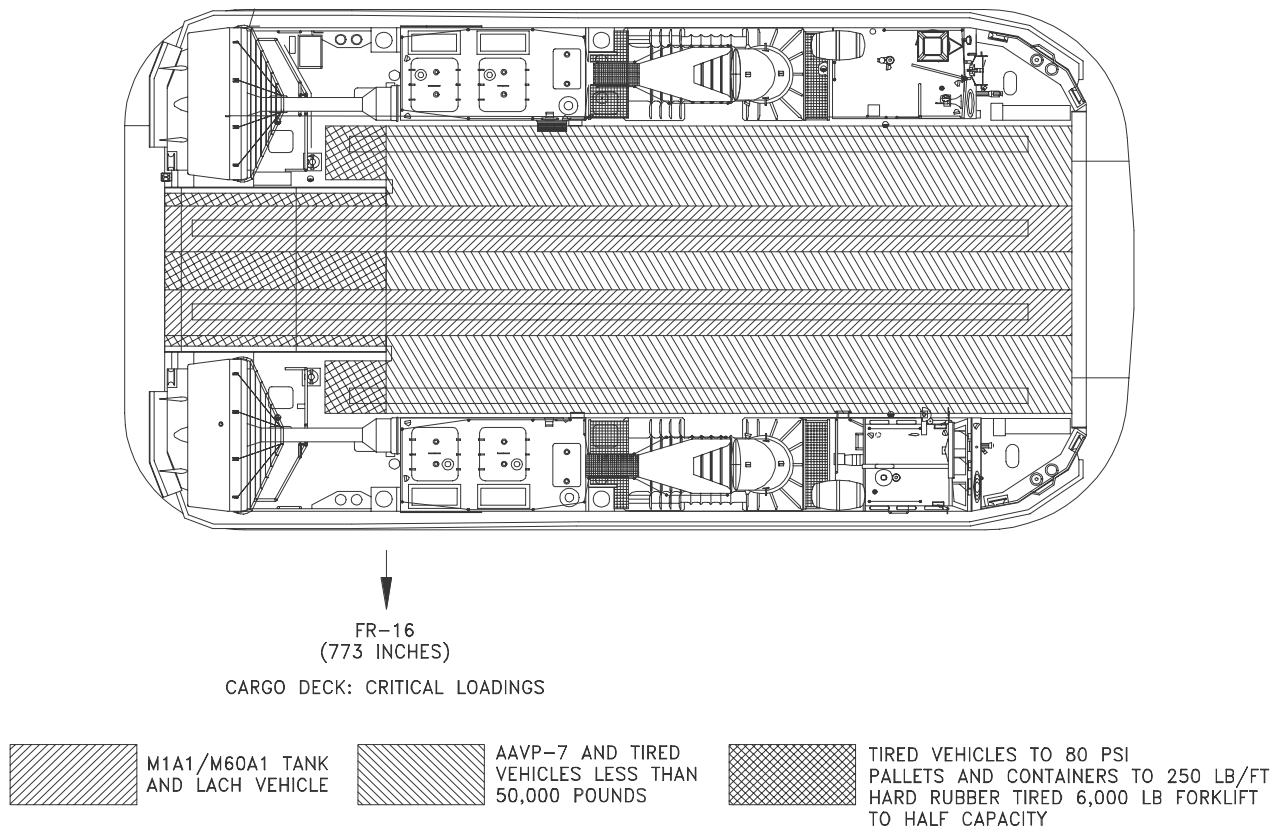


Figure 2-3 Cargo Deck Load Diagram

Table 2-1 Specific Limitations for the Craft and Cargo Deck

Item	Limitation
Maximum allowable craft weight	368,250 pounds
Optimal Operational (cargo and fuel) Longitudinal Center of Gravity (LCG) from the forward perpendicular (FP)	490-495
Optimal LCG loaded (lightship plus cargo)	487
Optimal Transverse Center of Gravity (TCG)	Centerline
Maximum allowable footprint without shoring	80 psi
Tracked and wheeled vehicles over 50,000 pounds	center rails only
6000 pound forklift (hard rubber tires) movement on deck load limit	3,000 pounds

2-3.2. **Tiedown Rails** The cargo deck has four rows of tiedown rails spaced approximately 99 inches apart with 2-inch diameter receptacles located between 12 and 15 inches apart along the entire length of the tiedown rail, see Figure 2-1 . The ultimate load capability for each tiedown socket is 40,250 pounds; working load is 35,000 pounds at the optimum 30 degree restraint angle.

2-4. **TROOP SEATS AND COMFORT PROVISIONS**

2-4.1. **Troop Seats** The LCAC has the capability of transporting up to 23 troops. Seats with seatbelts are provided for 7 troops in the starboard cabin and 16 in the port cabin as shown in Figure 2-4. One of the 7 troop seats on the starboard side is the troop commander seat which is on the crew deck (01 level). A wave commander seat is also provided on the 01 level behind the Craftmaster.

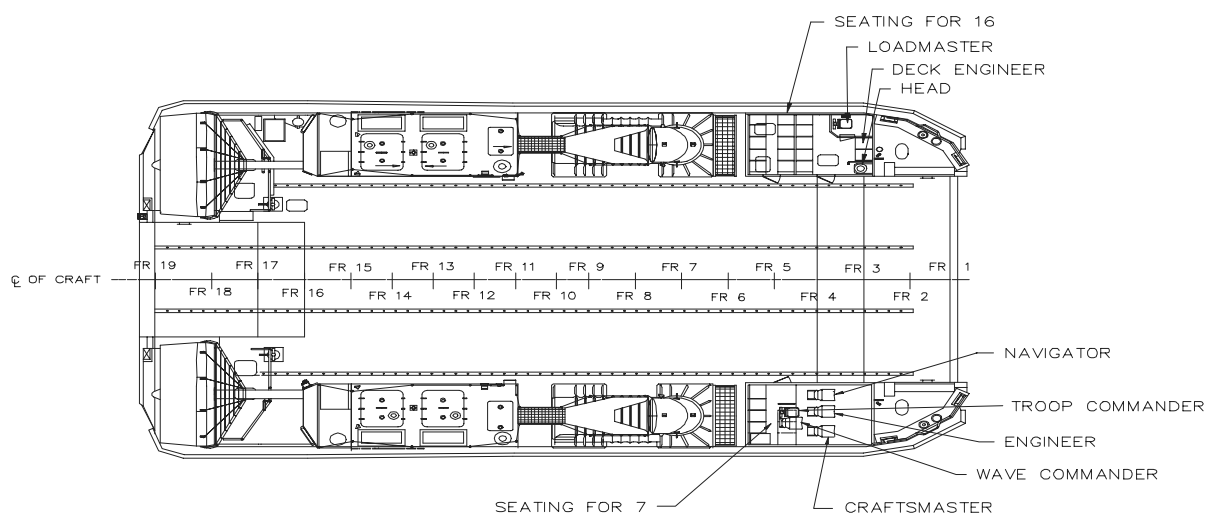


Figure 2-4 Crew and Passenger Seating

2-4.2. **Comfort Provisions** Comfort provisions, Figure 2-4, consist of a portable sanitary toilet, on the right side of the forward bulkhead of the port cabin, and a 5-gallon removable igloo water cooler, on the outboard bulkhead of the port cabin.

2-5. **RAMP SYSTEMS**

The LCAC has both a bow and stern ramp used for loading and offloading cargo. Both have an electrically driven hydraulically operated cable winch systems for raising and lowering the ramps.

2-5.1. **Bow Ramp** The bow ramp has two separate cable winch systems, one on each side adjacent to the port and starboard forward line handler stations as shown in Figure 2-5. The bow ramp is actuated by any of three switches marked UP/DOWN, one on the Craftmasters overhead panel and one on each of the port and starboard ramp pedestal covers. Either system is capable of raising or lowering the bow ramp. These two pedestal switches are mounted just above deck level on the forward outboard side of the

pedestals. The bow ramp speed is set by positioning a 2-way switch on the Craftmasters overhead panel to either SLOW or FAST. In the event of an electrical failure to both electrical pumps an emergency hydraulic hand pump can be connected to system hydraulic fitting on the aft end of the ramp pedestal to raise or lower the bow ramp. Each side of the bow ramp has a screw type cam lock for locking the ramp in the closed position once it is raised. Pip pins used to secure the screw handles into to the lock position extinguish the RAMP UNLOCK light on the Craftmasters overhead panel.

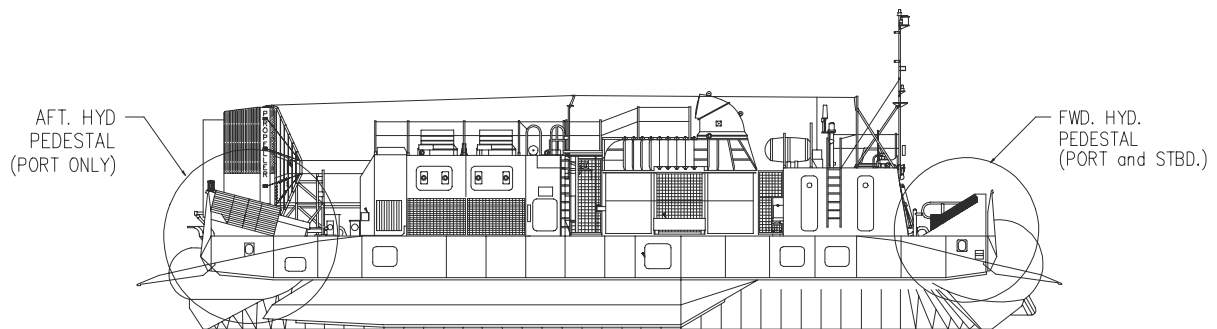


Figure 2-5 Location of Bow and Stern Ramp Hydraulic Pedestals

2-5.2. Stern Ramp The stern ramp system and operation is the same as the bow ramp except it only has a single hydraulic system. This system is located on the aft port side adjacent to the port propeller as shown in Figure 2-5 . The system is operated by either of two switches; one located on the Craftmasters overhead panel and the other mounted on the aft bulkhead adjacent to the stern ramp for TEXTRON built craft and on port engine module at frame 15 for AGM built craft. The switches are marked UP/DOWN and can operate at a fast or slow speed as selected on the Craftmasters overhead panel. Locking and emergency raising and lowering systems are identical to the bow ramp systems.

2-6. CREW COMMUNICATION

The LCAC communications system provides both internal and external communications capability for crewmembers. All systems provide for two-way communications except for the public address (PA) system which only provides one-way communications. Public address speakers are installed in both port and starboard crew compartments and externally on top of the port and starboard engine compartments. The communications equipment may vary among craft but all contain the same basic system of UHF, VHF, FM, HF, PA, and Man-on-the-Move (MOM) radio capability plus an internal voice communications system. External communications is provided for through the communications control units (CCU) as discussed in SEAOPS Volume I. Internal communication is provided for through the interior voice communication units (IVCUs), which is part of the CCU, the PA system and soundpowered phones. The

IVCU system is the primary internal communications system for the LCAC crew. The IVCUs are located in the port and starboard passenger compartments and by the cargo deck on each engine compartment as shown in Figure 2-6. The IVCUs are interconnected through a function box to all CCUs.

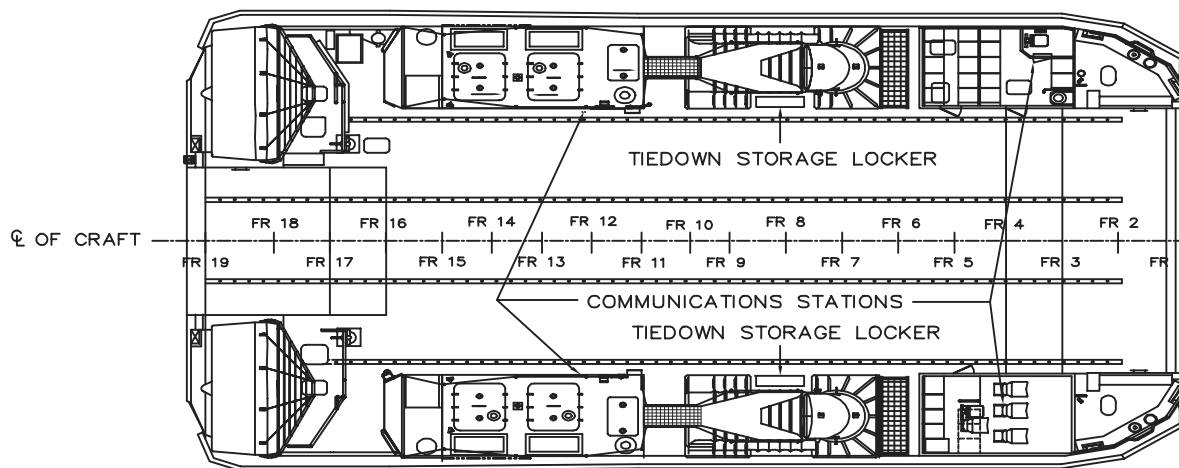


Figure 2-6 Communication Stations and Tiedown Storage Lockers

2-7. CARGO DECK LIGHTING

The LCAC has 14 deck lights which provide light for and around the cargo compartment. Eight of these are in the cargo deck area with four on each the port and starboard sides. There is one at each of the four linehandler stations and one at each the port and starboard life raft stations. Red lens are provided for wartime use with yellow lens the standard for peacetime. All the lights are controlled from the LIGHTS panel at the navigators station.

2-8. MISCELLANEOUS ITEMS

2-8.1. Stowage Of Cargo Handling Equipment Fifty cargo tiedowns are carried aboard each LCAC. There are two stowage lockers, one on each side of the craft, between the lift fans (Figure 2-6). Each locker holds 25 cargo tiedowns; any additional tiedowns are stored below decks. Shoring or dunnage materials, when carried separately will be strapped to the cargo deck.

2-8.2. Tiedown Devices The primary tiedown assembly used aboard the LCAC is the standard US Navy 35,000 pound working strength Peck and Hale Adjustamatic type tiedown lashing assembly with a LOK-ALOY-6 alloy connecting link, as shown in Figure 2-7. Each lashing shall have a cable length of 12 feet and be provided with 9 feet of adjustment beads. Cargo with no tiedown provisions must be restrained by cargo nets or the 5,000 pound aircraft tiedown restraints shown in Figure 2-8.

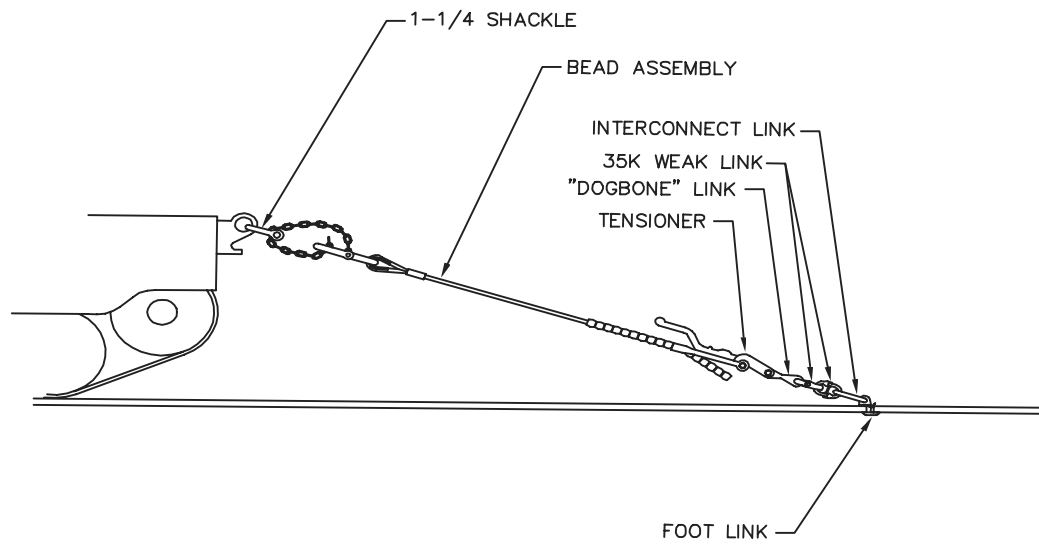
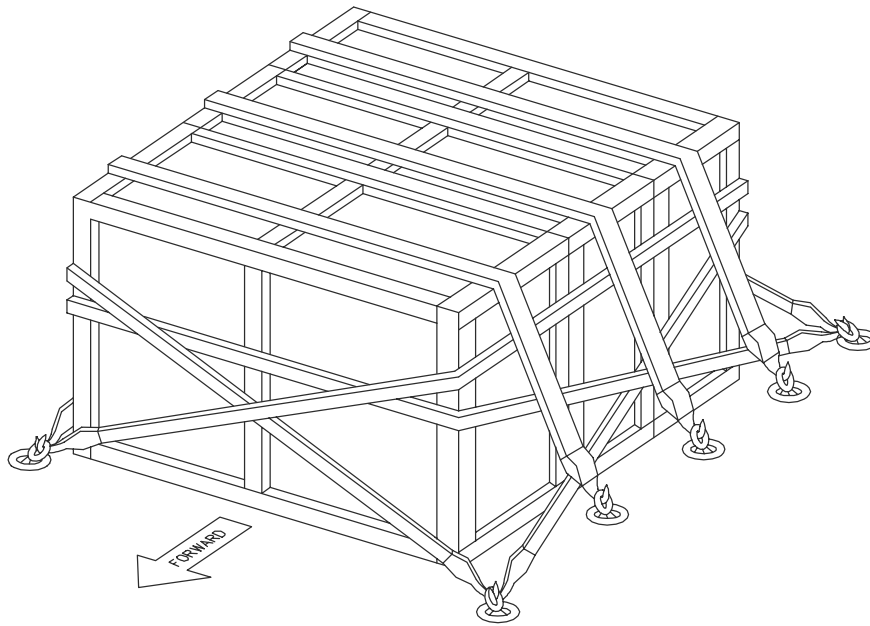
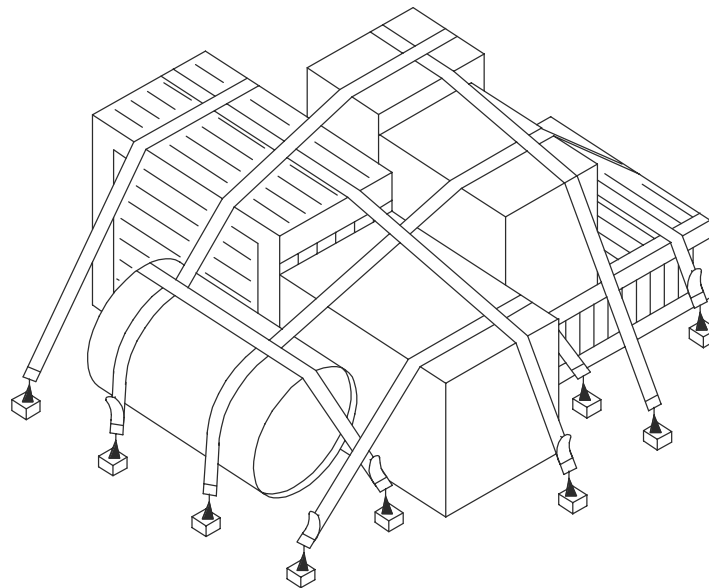


Figure 2-7 35,000 Pound Tiedown Assembly



TIEDOWN DEVICE APPLICATION TO CARGO
WITH NO TIEDOWN PROVISIONS



TYPICAL
COMPOSITE CARGO LOAD WITH NO
TIEDOWN PROVISIONS

Figure 2-8 Tiedowns for Cargo without Tiedown Provisions

CHAPTER 3

LCAC CONFIGURATION

3-1. GENERAL

This chapter provides information necessary for LCAC preparation for cargo missions.

3-2. DECK SAFETY

When the LCAC main engines are operating, the rotating equipment on the craft (lift fans, shafting, and propellers) is always potentially hazardous to all embarked personnel. Safety guidelines for operations on the cargo deck when these components are turning are provided in this chapter.

3-2.1. Two-Man Rule Whenever personnel are on deck with rotating equipment turning or during any other potentially hazardous operation, a TWO-MAN safety rule shall be used with each crewmember having the other under continual observation and communications. Should it become necessary for both to concentrate their efforts elsewhere, a third person such as the Navigator shall be dispatched to act as safety observer.

3-2.2. Precautions

- a. When the main engines are operating, all personnel on the main deck shall always be under the positive control of, and have reliable communications with the Craftmaster or Engineer via IVCS or MOM radio.
- b. Under no circumstances shall work be performed in the vicinity of the propeller FOD screens when the propellers are turning (see Figure 2-1).
- c. Under no circumstances will personnel be inside a FOD screen while a lift fan or propeller is turning or has the potential for turning (e.g., engine purge).
- d. All personnel on deck when the main engines are turning shall have eye and ear protection.

3-2.3. AFT of Frame 15 If conditions permit, main engines should be shut down when personnel are required to work aft of frame 15 (Figure 2-6). However, there are situations which require personnel to work in this area when craft propellers are turning. Therefore, personnel are allowed aft of frame 15 to perform required standard operating procedures such as those delineated below. These actions will be conducted with Craftmaster approval and under the direction of the Engineer or Loadmaster and will be conducted only when the craft is off-cushion and prop pitch is set as plus/minus 10 degrees or less.

The following procedures are examples of required procedures which must be performed aft of frame 15.

- a. Leak checks of after lube systems during engine start-up.
- b. Confirmation of scavenge fan and oil cooler operations.
- c. Investigation of a suspected low lube oil level.
- d. Investigation of a suspected lube oil or hydraulic system leak.
- e. Raising and lowering the stern ramp.

- f. Loading, unloading, griping, and ungriping of vehicles/cargo, including AAV launch.
- g. Towing operations.

3-3. **RAMP PREPARATION AND OPERATION**

3-3.1. **Ramp Preparation**

- a. Unlock ramp locks.



Before operating, either the bow or stern ramp, be sure ramp area is clear of obstructions and personnel to prevent damage to the craft and injury to personnel. When operating the ramp, be sure the cables are adequately restrained by the hydraulic cylinders.

- b. Lower ramps.



If the ramp is lowered onto soft sand or earth and loading/offloading of heavy cargo is possible, ensure the ramp hydraulic actuators are fully extended to provide additional cable for ramp settling.

3-3.2. **Ramp Operation**

NOTE

Electrical power for operation of the ramp is provided by either of two APUs.

- a. Speed switch to SLOW or FAST.
- b. Operate switch (Craftmaster's, or either of the two bow ramp or single stern) to DOWN to open the ramp.
- c. To stop the ramp at any position place the operate switch to OFF.
- d. To close ramp place operate switch to UP.

3-3.3. **Emergency Ramp Operation**

- a. Electrical failure.

1. To lower ramp, unlock the ramp camlocks, remove the hydraulic access plates on the hydraulic modules and rotate the hydraulic valve handle counterclockwise. Lower ramp to desired position. Close hydraulic valve and replace access plate.
2. To raise ramp, install emergency hydraulic hand pump via connections on the end of hydraulic module (Figure 3-1). Pump hydraulic hand pump until ramp is at desired position. When fully closed, engage ramp locks.

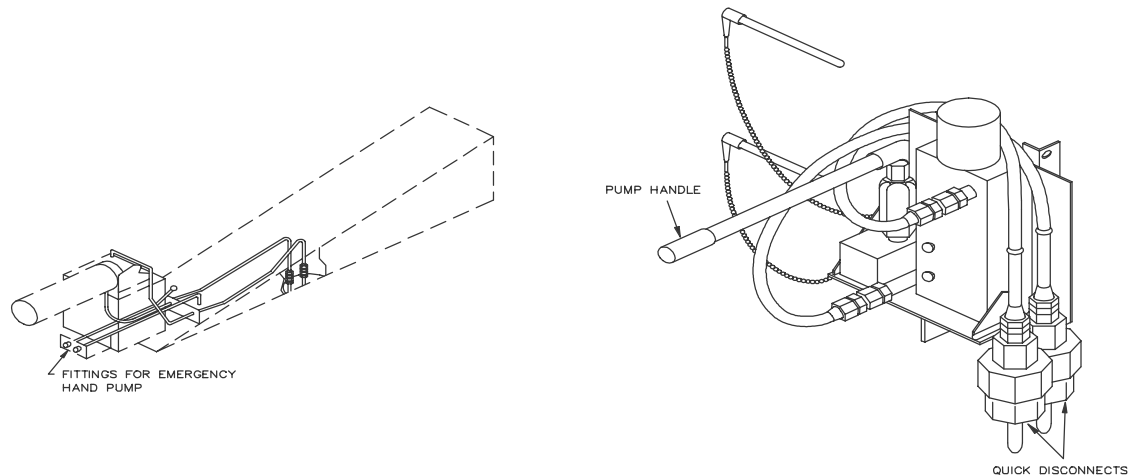


Figure 3-1 Ramp Emergency Hydraulic System

- b. Hydraulic failure (stern ramp only). See SEAOPS Volume 1, paragraph titled “Stern Ramp Raising Systems” for additional information on the three different systems for lowering or raising the stern ramp, on specific LCAC.
 1. To lower ramp:

WARNING

To prevent injury to personnel and damage to the ramp, the ramp must be supported and the area clear before the locks are released.

- (a.) Install the manually operated emergency ramp raising and lowering system.
 - (b.) Unlock ramp locks.
 - (c.) Slowly lower ramp with emergency system.
 - (d.) Remove and stow emergency ramp raising and lowering system.
2. To raise ramp:

- (a.) Install manually operated emergency ramp raising and lowering system.
- (b.) Raise to 37°, attach second come-along from deck to ramp and raise to stowed position.
- (c.) When fully closed engage ramp locks.
- (d.) Remove and stow emergency ramp raising and lowering system.

3-4. **CARGO DECK AND TIEDOWNS**

3-4.1. **Cargo Deck** The cargo deck shall be inspected before each mission, to ensure it is free from foreign object damage (FOD) and that all cargo deck receptacles are free from obstruction. The deck area around the ramps should be free of debris to ensure proper ramp operation. The cargo deck bulkheads should be inspected to ensure all panels are properly fastened and there are no obstructions for loading cargo. If shoring is required, ensure it is properly located on deck or properly secured for transit.

3-4.2. **Tiedowns** Each craft carries the normal allowance of 50 tiedown assemblies. Inspect all tiedown fittings to ensure proper operation. If additional tiedowns are required to secure cargo without cargo tiedown attachment points ensure cargo netting (MIL-S-18313) or aircraft strap type tiedown (MC-1/CGU-1/B 5000-pound capacity (see Figure 2-8) are available and if necessary, properly stowed.

3-5. **PASSENGER TRANSPORT**

The LCAC is capable of carrying 16 passengers in the port cabin and 7 passengers in the starboard cabin. SEAOPS Manual for Alternate Missions, S9LCA-AA-SSM-080 Volume VI, Chapter 1 contains a system description and operating procedures for Personnel Transport Module (PTM).

CHAPTER 4

GENERAL PROCEDURES

4-1. GENERAL

Load planning, loading, post loading, and offloading of personnel, general cargo and vehicles are described in this chapter.

4-2. LOAD PLANNING

Before loading the LCAC, five factors must be considered:

- a. Size - cargo must fit within cargo deck area.
- b. Weight and footprint - cargo weight and footprint must be within the structural limitations of the LCAC.
- c. Center of gravity - cargo must be arranged so the LCAC balance is maintained.
- d. Restraint - cargo must be restrained from undesired movement.
- e. FOD - cargo must be free of FOD.

4-2.1. Size Limitations The length and width of any crane loaded item must fit within the dimensions of the LCAC cargo deck and leave enough free space for entry into cabins and for engine air flow clearance as shown in Figure 2-1 . Vehicles entering the cargo deck must fit within the width of the bow or stern ramp.

4-2.2. Weight And Footprint Limitations LCAC weight definitions:

Lightship	Craft weight without fuel, crew, and cargo (from craft logbook).
Operating Weight	Craft weight with crew and crew equipment required for a mission.
Mission Weight	Operating weight plus fuel and cargo.
Maximum Allowable Craft Weight	368,250 pounds

Cargo weight is limited by the maximum gross weight of the craft and the strength of the cargo deck. The maximum weight of cargo that may be carried is determined by subtracting the operating weight plus fuel from maximum craft weight (Figure 4-1). Cargo loads must not be concentrated to exceed the deck limits shown in Figure 2-3 .

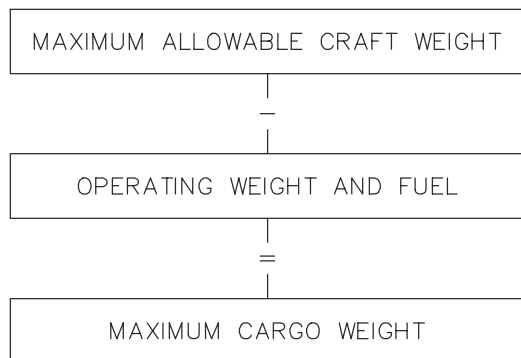


Figure 4-1 Maximum Cargo Weight Calculation

4-2.3. Center Of Gravity The LCAC has a point about which it will balance. This balance point is the center of gravity (CG). CG is affected by weight and both longitudinal (forward and aft) and transverse (port and starboard) distances. Any item which is added or removed from the LCAC will cause a shift in the balance of the LCAC and also cause the CG of the LCAC to shift, if the weight was not added or removed at the CG. If the CG shifts too far forward, aft, port or starboard, the LCAC will be unsafe for cushioned flight.

4-2.4. Restraint LCAC cargo is subjected to high wind, acceleration, vibration, seawater, pitching and rolling, and sudden stoppage. These forces act more strongly in some directions than others, and tend to shift the cargo unless it is properly restrained. Since the LCAC and cargo move forward during normal operation, the cargo will tend to keep on moving forward, unless properly restrained. However, if the LCAC is suddenly slowed by a change in speed (plow-in or emergency stop), grounding or crash, the cargo must be restrained against other forces trying to move it aft, from side-to-side (laterally), or up off the cargo deck floor (vertically).

4-2.5. FOD Cargo on the LCAC cargo deck is affected by all elements of weather and airflow across the craft during transit. This condition creates a FOD situation potentially dangerous to the craft. FOD can be anything left unsecured on vehicles or general cargo, the craft or in the well deck that could be blown into the propellers or lift fans, ingested into the engine inlets and cause damage to the craft or injury to personnel.

4-2.6. LCAC Weight And Force Distribution The LCAC, like an aircraft, must be properly loaded to maintain craft design operating characteristics. Unbalanced loading can lead to craft damage and prevent mission accomplishment. This can be prevented through proper loading.

4-2.7. Weight And Balance Determination To assist in understanding LCAC weight and force distribution theory and application in load planning, an understanding of CG is required. The LCAC is designed to fly in a slightly nose up attitude (1 degree) with craft and cargo in a balanced condition when the LCG is 490-495 and TCG is centerline. These are the best LCG and TCG operating positions. To get this LCG, the craft (lightship plus cargo) must be loaded to a LCG of 487. After fuel is added to the loaded craft, the LCG will be between 490 and 495. The limiting LCG positions based on SWH and gross weight are shown in Figure 4-2.

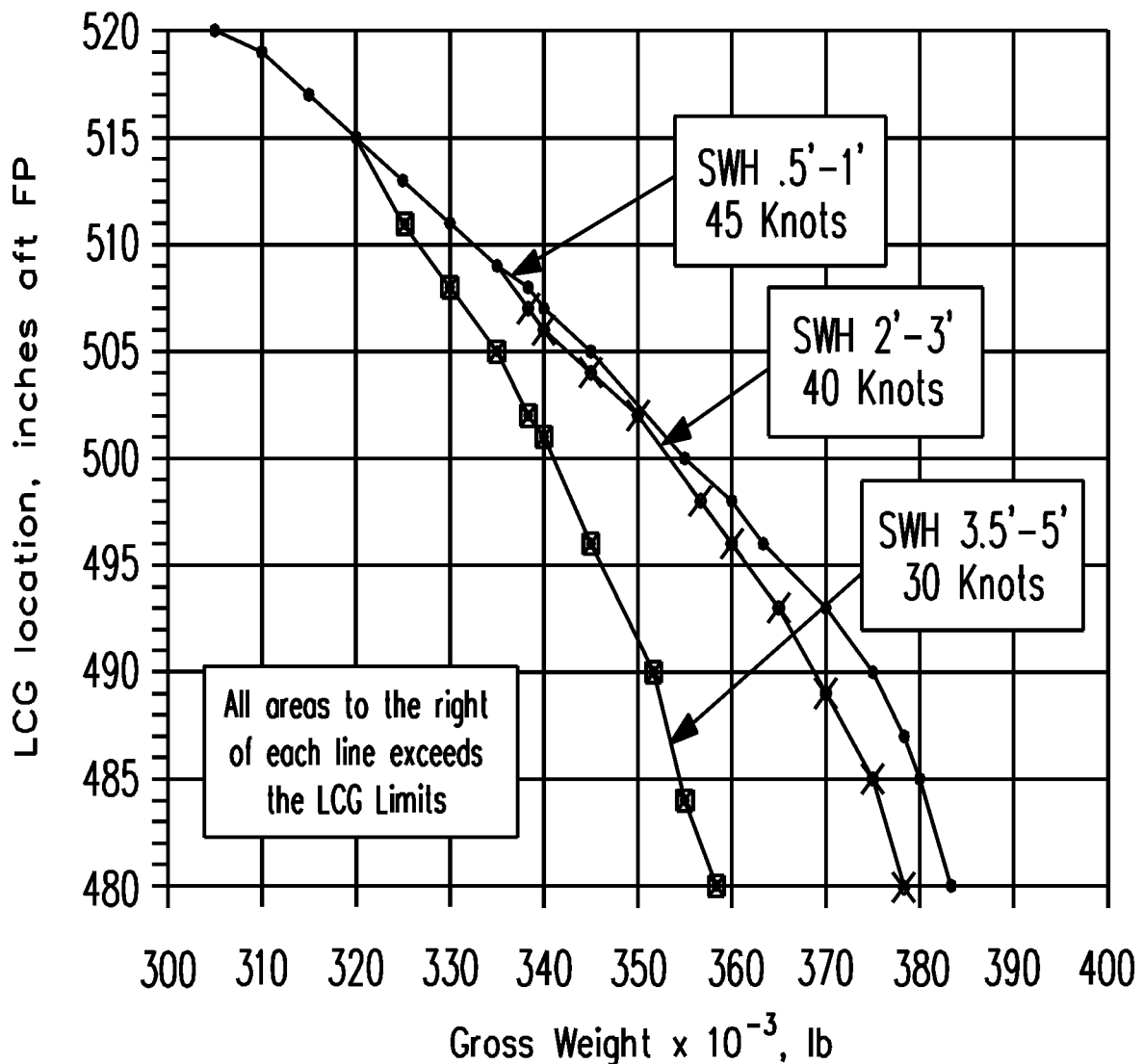


Figure 4-2 LCAC Limiting LCG Position Based on Significant Wave Height (SWH) and Gross Weight

For operational efficiency, each LCAC must be in balance, at the correct attitude, and operating within cargo weight limits at a desired speed. Cargo is the major consideration for balancing the craft. Cargo weight and distance from the craft CG affect craft balance.

Weight and balance in the LCAC deals primarily with balance along the fore and aft and athwartship axes. Balance along the vertical axis can normally be ignored for commonly carried vehicles and loads, since the effects of the vertical moment on performance and control are negligible throughout the craft operating range. Unusual loads such as cranes and excavators, which have an unusually high vertical CG, could adversely impact the vertical CG of the craft. Inherently, few options exist for the crew to reduce the effect of high vertical CG. To minimize this CG add tiedowns to increase vertical stability and use prudent seamanship while underway. The empty craft, allowance list items, fuel on board, and the crew and passengers each develop a fixed moment in both the fore and aft and athwartship axes. The moments required to trim the craft must come primarily from the positioning of cargo. Transferring fuel provides limited additional trim capability.

In making cargo weight and balance determinations, two different CGs must be figured.

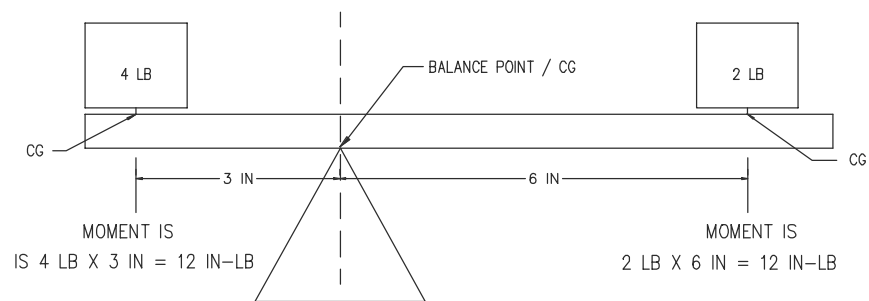
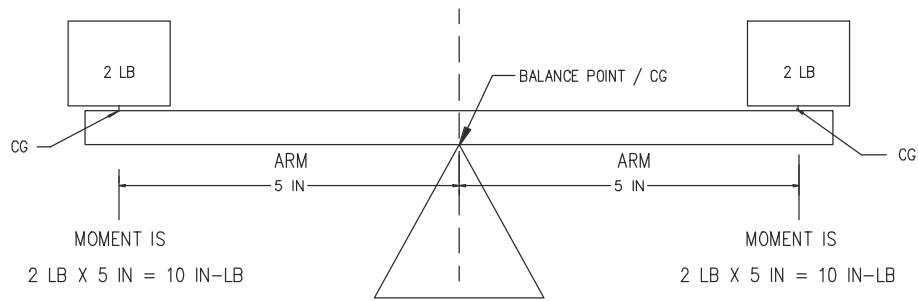
- a. Vehicle/Cargo CG - This CG is the balance point for the vehicle/cargo. The CG is a three dimensional point that has longitudinal, transverse, and vertical components. For LCAC weight and balance calculations, the vertical component is not normally considered and the TCG is assumed to be located at the centerline of the vehicle/cargo (one-half of the vehicle/cargo width). The LCG of the vehicle/cargo is the only component required to be computed.
- b. Total Cargo CG - This CG is the single point at which the entire weight of the cargo on the LCAC combine into a single force.

4-2.8. Cargo Center Of Gravity Planning To properly load the LCAC, the following planning steps must be completed after cargo load is known:

- a. Determine total cargo weight (includes crew, passengers, and cold weather kit) and CG of all cargo.
- b. Determine lightship weight, LCG and TCG (from craft logs).
- c. Determine Longitudinal and Transverse Cargo Load Center, round to nearest foot and mark on cargo deck worksheet.
- d. Spot vehicles on cargo deck worksheet and calculate the debit (minus) or credit (plus) value. Using the 1 foot grid system, locate and mark the CG of the cargo; measure the distance fore or aft to the Longitudinal Cargo Load Center; and measure the distance port or starboard to the transverse cargo load center. Enter all data on the LCAC Cargo Load Plan Form.
- e. Total all debits (minus values) and credits (plus values) on LCAC Cargo Load Plan. Ensure the sum is equal to 0 or slightly positive (+10,000 or less). Relocate vehicles (cargo) until the load meets this requirement.
- f. Use completed cargo deck worksheet to spot vehicles on the craft. Once the craft is loaded, add the cargo deck worksheet to craft file of cargo loads.

4-2.8.1. Weight And Moment The process used to balance a load on the LCAC requires solving a weight and moment problem. Three components of this problem are: weight, arm, and moment. Weight is the number of pounds an object weighs; arm is the distance in inches from the point of rotation or

balance point to the center of the weight; and moment is weight multiplied by the arm length, or $M = (W)(A)$. For balancing loads on an LCAC, the balance point is known as the craft CG (Figure 4-3). Examples of two different balance problems are shown of Figure 4-3. In the first problem, both weights are 2 pounds and both arms are 5 inches in length; therefore, when multiplying length 2 times arm 5 both values are 10 and the beam is balanced. In the second problem, the 4-pound weight is 3 inches from the balance point or CG while the 2-pound weight is 6 inches from the balance point or CG. However, when length of arm and weight are multiplied the values are the same and the beam is balanced. In the third example, the LCAC and cargo replaces the two weights to show how weight and moment apply to loading an LCAC. In this case the aft block represents the LCAC weight while the forward block represents the cargo to be loaded on the LCAC.



NOTE: BOTH EXAMPLES ARE IN BALANCE SINCE THE VALUE FOR WEIGHT X ARM IS EQUAL FOR BOTH SIDES OF THE BALANCE POINT.

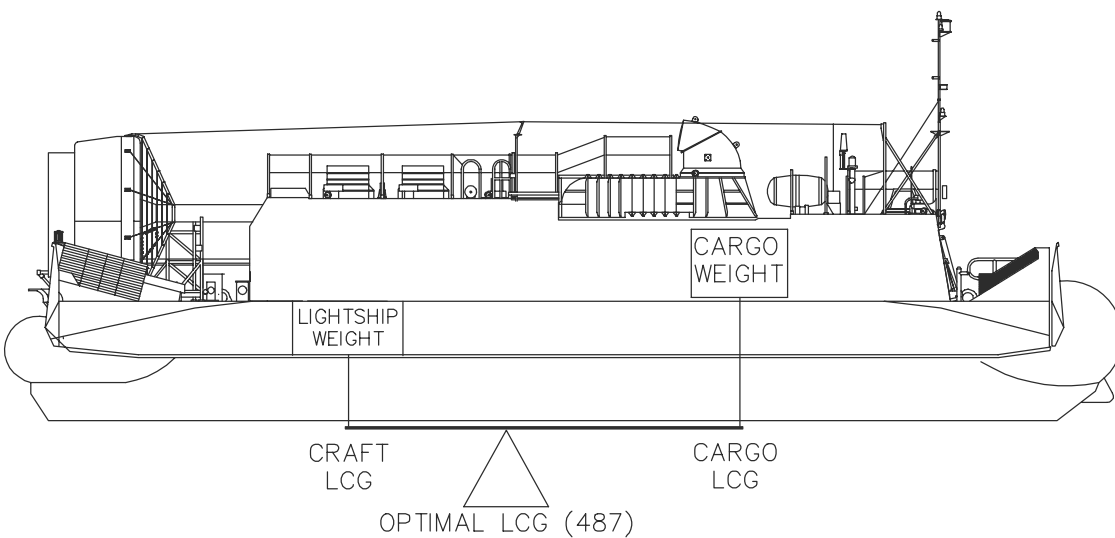


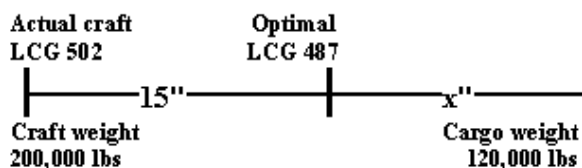
Figure 4-3 Examples of Weight and Moment Problems

For purposes of simplifying the load calculation process, a system of debits (minus values) and credits (plus values) is used. This process is based upon simple arithmetic calculations to balance the LCAC. After determining, the Longitudinal Cargo Load Center, which is the total weight of the cargo balanced with the lightship weight of the craft at the LCG of 487 as shown in Figure 4-3, the craft should be loaded by lanes to keep the craft balanced in the athwartships axis. Since most LCAC already have a 5 to 6 inch starboard TCG it is necessary to keep the cargo load balanced transversely (equal weight on either side of centerline). When it is not possible to balance a load transversely, place the heaviest portion on the port side of the craft. Likewise, when loading single large vehicles (M1A1 tank, etc.) the load should be balanced both longitudinally and transversely. The same process is used to find both the Longitudinal and Transverse Cargo Load Center. When balancing transversely, the cargo must be moved out of lane centerline. When cargo is not centered, cargo tiedowns will not be symmetrical and restraint will have to be figured for each single tiedown. The following sample problem shows how to find the Longitudinal Cargo Load Center and the Transverse Cargo Load Center for loading an LCAC.

4-2.8.2. **SAMPLE PROBLEM** For a craft that weighs 200,000 pounds and has a LCG of 502 and a TCG of 6 inches starboard, find the Longitudinal and Transverse Cargo Load Centers for a cargo load that weighs 120,000 pounds. See Table 4-1.

Table 4-1 Longitudinal Center of Gravity

<u>Craft Characteristic</u>		<u>Weight/Distance</u>
Craft lightship weight	=	200,000 lbs
Craft LCG	=	502
Cargo weight	=	120,000 lbs
Optimal LCG with Cargo	=	487
Longitudinal cargo load center	=	487-X

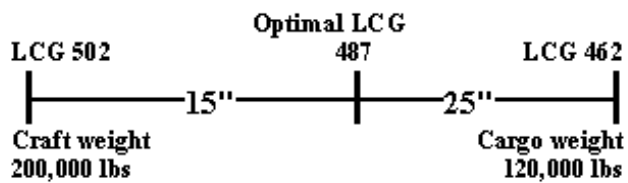


Solve the following equation, as a weight and moment problem, to find the length of moment arm (x). See Table 4-2.

Table 4-2 Weight and Moment Problem

<u>Weight of Craft</u>		<u>Weight of Cargo</u>
(200,000) x arm(15)	=	(120,000) x arm(X)
(200,000)(15)	=	(120,000)(X)
3,000,000	=	120,000X
Divide each side by 120,000		
3,000,000 / 120,000	=	120,000X / 120,000
25	=	X
Longitudinal cargo load center is	=	462
487 - 25		

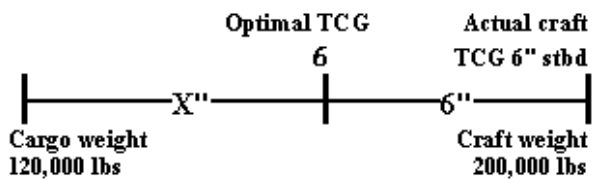
Therefore, the cargo load LCG must be located 25" forward of 487 at position 462 to balance the loaded craft at the optimal LCG of 487.



This same weight and moment process should be used to balance the craft transversely. The optimum TCG location is craft CenterLine. If craft TCG is not centerline. then the cargo could be offset port from the individual lane centerline by the number of inches determined by solving the following sample problem in Table.4-3.

Table 4-3 Transverse Center of Gravity

<u>Craft Characteristic</u>	<u>Weight/Distance</u>
Craft lightship weight	= 200,000 lbs
Craft TCG	= 6 inch starboard
Cargo weight	= 120,000 lbs
Optimal TCG	= CenterLine

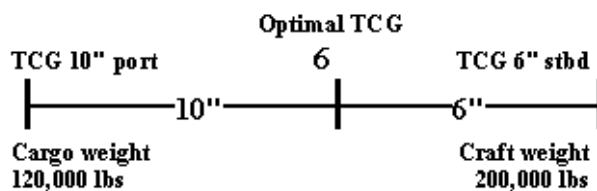


Solve the following equation, as a weight and moment problem, to find the length of the moment arm (x). See Table 4-4.

Table 4-4 Weight and Moment Problem

Weight of Craft		Weight of Cargo	
$(200,000) \times \text{arm}(6)$	=	$(120,000) \times \text{arm}(X)$	
1,200,000	=	120,000X	
Divide each side by 120,000			
$1,200,000 / 120,000$	=	$120,000X / 120,000$	
10 inches	=	X	

As shown, the cargo TCG must be located 10 inches port of centerline to balance the loaded craft at the optimal TCG of centerline.



NOTE

When placing cargo in other than the centerline position of each lane, restraint for each individual tiedown must be figured individually for longitudinal and vertical directions instead of for pairs as is normally done when cargo is centerline, because of loss of cable symmetry (see Paragraph 4-4.).

Movement to port by 10 inches means to shift the cargo in each lane 10 inches to port of lane centerline without blocking crew and equipment access hatches.

4-2.8.3. CG Calculations For Loading Cargo Lanes (Debits And Credits) After completing the steps required to establish the overall LCG and TCG cargo placement location for the total cargo load, actual placement of individual cargo by lane must be developed.

The LCAC cargo deck is divided into 3 lanes. With the exception of the limitations on tracked vehicles and footprint limitations of cargo (see Figure 2-3) cargo can be placed anywhere on the deck. Operational considerations usually dictate that all vehicles be loaded longitudinally for rapid on/offloading. Therefore, loading of vehicles and cargo is generally done by lanes. Having previously determined location of the total cargo load LCG, it is necessary to determine the spotting of individual vehicles and cargo. To load, complete the following steps.

- a. Determine Vehicle/Cargo CG. Most USMC equipments are listed in the Vehicle Loading Pocket Handbook, which contains weight, CG, length, and other data. For other vehicles use the following listing shown in Table 4-5 to determine CG. (See Figures 4-4, 4-5, 4-6, and 4-7).

Table 4-5 How to Determine CG

Situation	Solution
Vehicle CG unknown	Compute CG from axle weights (Figure 4-4)
Trailer CG unknown	Compute CG from axle weight (Figure 4-5)
Partially loaded vehicle, CG unknown	Compute CG using empty and loaded CG values (Figure 4-6)
Vehicle-trailer combined, CG unknown	Compute combined CG as shown (Figure 4-7)

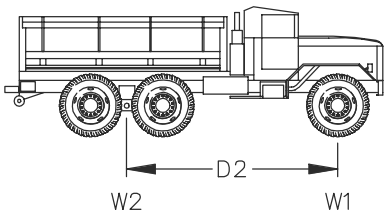
EXAMPLE-D1059											
											
<p>VEHICLE DATA:</p> <table style="width: 100%; border: none;"> <tr> <td style="width: 60%;">W1= WEIGHT OF FRONT AXLE=</td> <td style="border: 1px solid black; text-align: center; width: 40%;">10205 lb.</td> </tr> <tr> <td>W2= WEIGHT OF REAR AXLE OR AXLES=</td> <td style="border: 1px solid black; text-align: center;">11870 lb.</td> </tr> <tr> <td>D2= DISTANCE BETWEEN FRONT AXLE AND MID-POINT OF REAR AXLES=</td> <td style="border: 1px solid black; text-align: center;">179 in.</td> </tr> <tr> <td>CGV= CG OF VEHICLE=</td> <td style="border: 1px solid black; text-align: center;">UNKNOWN</td> </tr> </table>				W1= WEIGHT OF FRONT AXLE=	10205 lb.	W2= WEIGHT OF REAR AXLE OR AXLES=	11870 lb.	D2= DISTANCE BETWEEN FRONT AXLE AND MID-POINT OF REAR AXLES=	179 in.	CGV= CG OF VEHICLE=	UNKNOWN
W1= WEIGHT OF FRONT AXLE=	10205 lb.										
W2= WEIGHT OF REAR AXLE OR AXLES=	11870 lb.										
D2= DISTANCE BETWEEN FRONT AXLE AND MID-POINT OF REAR AXLES=	179 in.										
CGV= CG OF VEHICLE=	UNKNOWN										
<p>EQUATION: $CGV = \frac{W2 \times D2}{W1 + W2}$</p>											
<p>SOLUTION:</p> <p>MULTIPLY: W2 11870 x D2 179 = ANS A 2124730</p> <p>then</p> <p>ADD: W1 10205 + W2 11870 = ANS B 22075</p> <p>then</p> <p>DIVIDE: ANS A 2124730 ÷ ANS B 22075 = CGV 96 in.</p>											

Figure 4-4 CG of Axled Vehicles Using Axle Weights

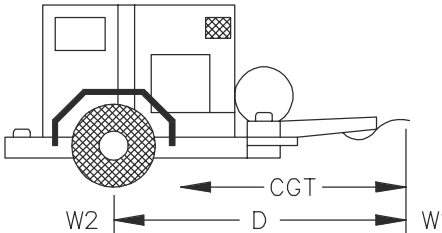
EXAMPLE-B1016/D0080											
											
<p>VEHICLE DATA:</p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 40%;">W1= WT. OF TRAILER TONGUE=</td> <td style="border: 1px solid black; text-align: center; width: 15%;">764 lb.</td> </tr> <tr> <td>W2= AXLE WEIGHT=</td> <td style="border: 1px solid black; text-align: center;">6876 lb.</td> </tr> <tr> <td>D= AXLE-TONGUE DISTANCE=</td> <td style="border: 1px solid black; text-align: center;">140 in.</td> </tr> <tr> <td>CGT= LOCATION OF CG MEASURED FROM TONGUE=</td> <td style="border: 1px solid black; text-align: center;">UNKNOWN</td> </tr> </table>				W1= WT. OF TRAILER TONGUE=	764 lb.	W2= AXLE WEIGHT=	6876 lb.	D= AXLE-TONGUE DISTANCE=	140 in.	CGT= LOCATION OF CG MEASURED FROM TONGUE=	UNKNOWN
W1= WT. OF TRAILER TONGUE=	764 lb.										
W2= AXLE WEIGHT=	6876 lb.										
D= AXLE-TONGUE DISTANCE=	140 in.										
CGT= LOCATION OF CG MEASURED FROM TONGUE=	UNKNOWN										
<p>EQUATION: $CGT = \frac{D \times W2}{W1 + W2}$</p>											
<p>SOLUTION:</p> <p>MULTIPLY: D 140 x W2 6876 = ANS A 962640</p> <p>then</p> <p>ADD: W1 764 + W2 6876 = ANS B 7640</p> <p>then</p> <p>DIVIDE: ANS A 962640 ÷ ANS B 7640 = CGT 126</p> <p style="text-align: right; margin-right: 50px;">in. FROM TONGUE OF TRAILER</p>											

Figure 4-5 CG of Single Axle Trailer

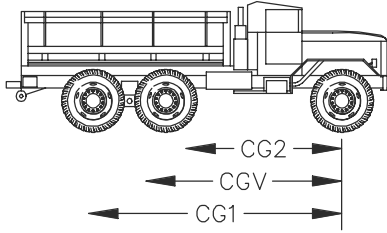
EXAMPLE-D1059															
															
<p>VEHICLE DATA:</p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 60%;">CG1= FULL LOAD CG=</td> <td style="border: 1px solid black; text-align: center; width: 40%;">123 in.</td> </tr> <tr> <td>CG2= EMPTY LOAD CG=</td> <td style="border: 1px solid black; text-align: center;">97 in.</td> </tr> <tr> <td>CGV= PARTIAL LOAD CG=</td> <td style="border: 1px solid black; text-align: center;">UNKNOWN</td> </tr> <tr> <td>W1= FULLY LOADED VEHICLE WEIGHT=</td> <td style="border: 1px solid black; text-align: center;">31600 lb.</td> </tr> <tr> <td>W2= EMPTY VEHICLE WEIGHT=</td> <td style="border: 1px solid black; text-align: center;">NOT REQUIRED</td> </tr> <tr> <td>WV= PARTIALLY LOADED VEHICLE WEIGHT=</td> <td style="border: 1px solid black; text-align: center;">28000 lb.</td> </tr> </table>				CG1= FULL LOAD CG=	123 in.	CG2= EMPTY LOAD CG=	97 in.	CGV= PARTIAL LOAD CG=	UNKNOWN	W1= FULLY LOADED VEHICLE WEIGHT=	31600 lb.	W2= EMPTY VEHICLE WEIGHT=	NOT REQUIRED	WV= PARTIALLY LOADED VEHICLE WEIGHT=	28000 lb.
CG1= FULL LOAD CG=	123 in.														
CG2= EMPTY LOAD CG=	97 in.														
CGV= PARTIAL LOAD CG=	UNKNOWN														
W1= FULLY LOADED VEHICLE WEIGHT=	31600 lb.														
W2= EMPTY VEHICLE WEIGHT=	NOT REQUIRED														
WV= PARTIALLY LOADED VEHICLE WEIGHT=	28000 lb.														
<p>EQUATION: $CGV = (CG1 - CG2) \times \frac{WV}{W1} + CG2$</p>															
<p>SOLUTION:</p> <p>SUBTRACT: CG1 123 - CG2 97 = ANS A 26</p> <p>then</p> <p>MULTIPLY: ANS A 26 x WV 28000 = ANS B 728000</p> <p>then</p> <p>DIVIDE: ANS B 728000 ÷ W1 31600 = ANS C 23</p> <p>then</p> <p>ADD: ANS C 23 + CG2 97 = CGV 120 in. FROM FRONT AXLE</p>															

Figure 4-6 CG of Partially Loaded Vehicle

EXAMPLE-D1059 TOWING E0665														
<p>VEHICLE DATA:</p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%;">W1= WEIGHT OF FRONT AXLE=</td> <td style="width: 50%; border: 1px solid black; text-align: center;">10205 lb.</td> </tr> <tr> <td>W2= WEIGHT OF REAR AXLE=</td> <td style="border: 1px solid black; text-align: center;">11870 lb.</td> </tr> <tr> <td>W3= WEIGHT OF TRAILER AXLE=</td> <td style="border: 1px solid black; text-align: center;">12640 lb.</td> </tr> <tr> <td>D2= DISTANCE BETWEEN FRONT AXLE AND MID-POINT OF REAR AXLES=</td> <td style="border: 1px solid black; text-align: center;">179 in.</td> </tr> <tr> <td>D3= DISTANCE FROM TRUCK FRONT AXLE TO TOWED LOAD AXLE=</td> <td style="border: 1px solid black; text-align: center;">549 in.</td> </tr> <tr> <td>CGC= CG OF TRUCK-TRAILER COMBINATION=</td> <td style="border: 1px solid black; text-align: center;">UNKNOWN</td> </tr> </table>			W1= WEIGHT OF FRONT AXLE=	10205 lb.	W2= WEIGHT OF REAR AXLE=	11870 lb.	W3= WEIGHT OF TRAILER AXLE=	12640 lb.	D2= DISTANCE BETWEEN FRONT AXLE AND MID-POINT OF REAR AXLES=	179 in.	D3= DISTANCE FROM TRUCK FRONT AXLE TO TOWED LOAD AXLE=	549 in.	CGC= CG OF TRUCK-TRAILER COMBINATION=	UNKNOWN
W1= WEIGHT OF FRONT AXLE=	10205 lb.													
W2= WEIGHT OF REAR AXLE=	11870 lb.													
W3= WEIGHT OF TRAILER AXLE=	12640 lb.													
D2= DISTANCE BETWEEN FRONT AXLE AND MID-POINT OF REAR AXLES=	179 in.													
D3= DISTANCE FROM TRUCK FRONT AXLE TO TOWED LOAD AXLE=	549 in.													
CGC= CG OF TRUCK-TRAILER COMBINATION=	UNKNOWN													
<p>EQUATION:</p> $CGV = \frac{(W2 \times D2) + (W3 \times D3)}{W1 + W2 + W3}$														
<p>SOLUTION:</p> <p>MULTIPLY: W2 11870 x D2 179 = ANS A 2124730</p> <p>MULTIPLY: W3 12640 x D3 549 = ANS B 6939360</p> <p>ADD: ANS A 2124730 + ANS B 6939360 = ANS C 9064090</p> <p>ADD: W1 10205 + W2 11870 + W3 12640 = ANS D 34715</p> <p>DIVIDE: ANS C 9064090 ÷ ANS D 34715 = CGC 261 in.</p>														

Figure 4-7 CG of Vehicle-Trailer Combination Using Axle Weights

- b. Determine Debits (minus) and Credits (plus). With the weights and CG of cargo known, the Loadmaster shall spot cargo on Cargo Deck Worksheet (Figure 4-8) balancing it at LCG using debits and credits. A debit (minus value) is any cargo with a CG located aft of the Longitudinal Cargo Load Center, while a credit (plus value) is any cargo with a CG located forward of the Longitudinal Cargo Load Center. The value for the debits and credits is determined by multiplying the cargo weight times the distance in feet from cargo CG to the Longitudinal Cargo Load Center. The weight for USMC vehicles can be found in Table 4-6. The debit and credit value can be found in Tables 4-6, 4-8, 4-9, 4-10, 4-11, 4-12, 4-13, 4-14, 4-15, 4-16, and 4-17 by reading across the top of the table to find the cargo weight and then reading down the left hand column find the distance in feet the cargo CG is from the Longitudinal Cargo Load Center. The number at the intersection of the two lines (see sample problem for example) is the debit/credit value. The values in the columns of the credit/debit table are listed in 1,000-pound increments. When spotting a load, round the weight to the nearest 1,000 pounds prior to using the table. Continue this process until the LCAC is loaded and the sum of all credits and debits is equal to 0 or slightly positive (10,000 or less). Enter all data on the cargo load plan (Figure 4-9).

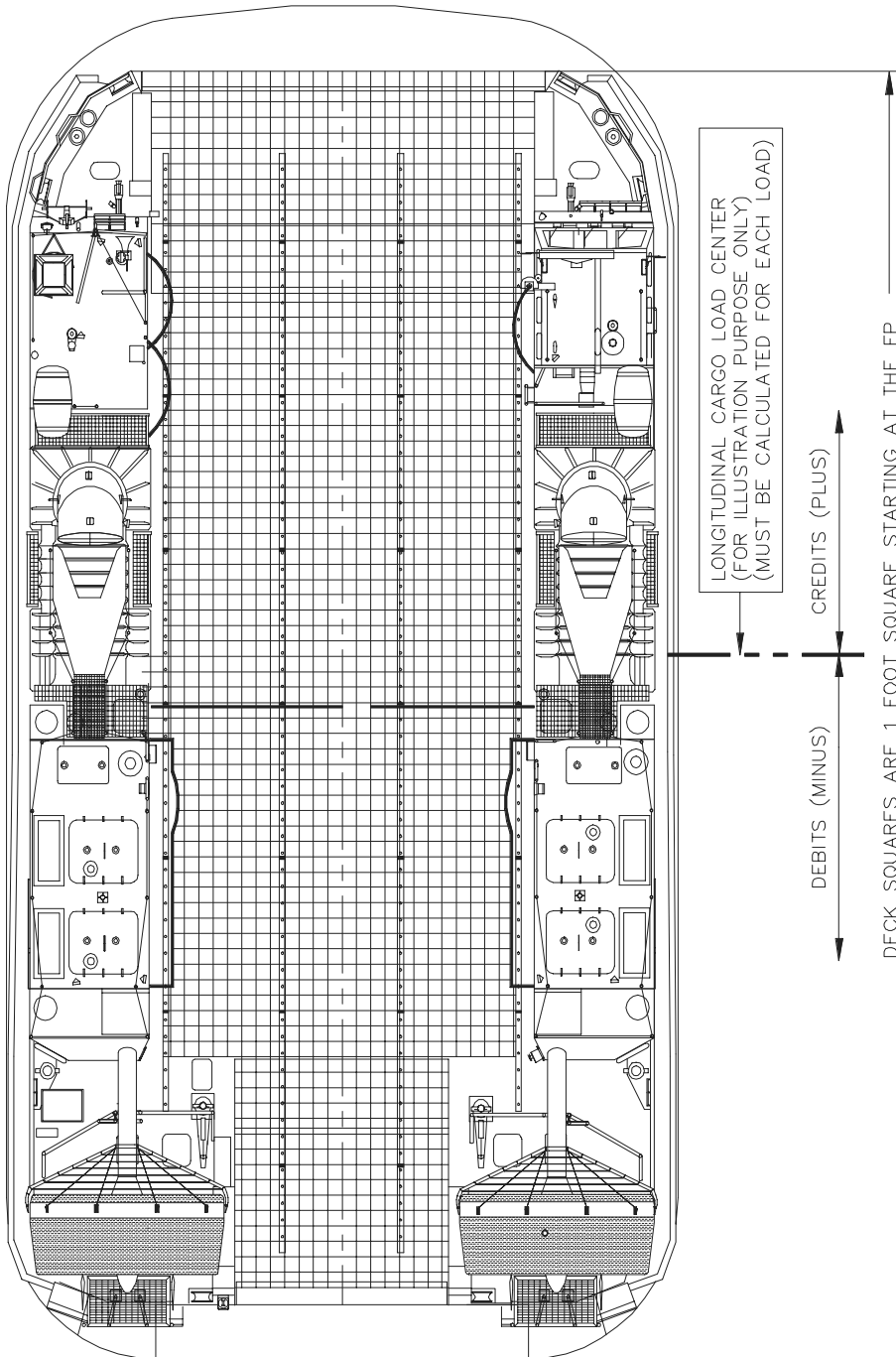


Figure 4-8 LCAC Longitudinal Cargo Load Center (Cargo Deck Worksheet)

Table 4-6 List of USMC Equipment

TAMCN	NOMENCLATURE	MAXIMUM WEIGHT (lb)
A1930	Radio set, AN/MRC-110 HMMWV-MTD	8000
A1935	Radio set, AN/MRC-138 HMMWV-MTD	8000
A2182	Radio set, AN/MRC-134 HMMWV-MTD	8000
A2183	Radio set, AN/MRC-135 HMMWV-MTD	8000
B0391	Container Handler, RT 50000 LB	107000
B0444	Crane, WHLD-MTD, RT, 7-1/2 Ton Grove	24800
B0590	Excavator, Hydraulic, Multi-Pur WHLD MC40DR	37800
B0630	Floodlight Set, Elec, Essex, TRLR-MTD	2500
B0635/D0080	Floodlight Set, TRLR-MTD W/Tower	6000
B09531D0080	Generator Set, 30 KW, 60 Hz, TRLR-MTD MEP-005A	6000
B0971/D0080	Generator Set, 30 KW, 400 Hz TRLR-MTD MEP-114A	5800
B1016/D0080	Generator Set, 60 KW, 400 Hz, TRLR-MTD MEP-115A	7600
B1021/D0080	Generator Set, 60 KW, 60 Hz, SKID-MTD MEP-006A	7200
B1081	Grader, Road Motorized	30800
B1298/D0080	Line Charge Launch Kit, TRLR-MTD	7000
B1945	Shop Equip, Contact Maint, M1031 Chassis	7900
B1950	Shop Equip Set, Gen Pur, Repair	9500
B2462/B1775	Tractor, MED, D7G, W/Ripper	53700
B2462/B2705	Tractor, MED, D7G, W/Winch	51500
B2463	Tractor, Full Tracked W/Multi-Pur Bucket MCI 150	27600
B2465/B0214	Tractor, Rubber-Tired, 72-31 w/Bucket	29700
B2465/B0647	Tractor, Rubber-Tired, 72-31 w/Fork	33300
B2467	Tractor, RT, WHLD, Industrial MC5808	10000
B2482	Tractor, All Wheel Drive W/Attachments	16100
B2560	Truck, Forklift MC-6000 RTL	19500
B2565	Truck, Forklift MC-4000 RTL	8200
B2567/B0215	Tractor, Rubber-Tired, Articulated Steering, Multipurpose (TRAM) W/Bucket	36300
B2567/B0647	Tractor, Rubber-Tired, Articulated Steering, Multipurpose (TRAM) W/Fork	36700

Table 4-6 List of USMC Equipment (Cont.)

TAMCN	NOMENCLATURE	MAXIMUM WEIGHT (lb)
D0085	TRLR, Flatbed, 2 Wheel Drive, 3/4 Ton, M116A2	2800
D0190	Lub and Serv Unit Power Operated	5800
D0209/D0876	MK 48/MK 14 Container Hauler (LVS)	65300
D0209/D0877	MK 48/MK 15 Wrecker (LVS)	75000
D0209/D0878	MK 48/MK 16 Fifth Wheel (LVS)	41500
D0209/D0879	MK 48/MK 17 Cargo Hauler (LVS)	67200
D0840	TRLR, Cargo, 1/4 Ton, M416	1200
D0850	TRLR, Cargo, 2-WHLD, 3/4 Ton, M101A1 W/Side Racks and Canvas	2900
D0860	TRLR, Cargo, 2-WHLD, 2-1/2 Ton, M105A2 W/Side Racks 1	5700
D0875	TRLR, Flatbed, 2-WHLD, 3/4 Ton, M762	2100
D0880	TRLR, Tank, Water, 400 Gal, 2-WHLD, 1-1/2 Ton, M149A2	6000
D0918	Truck, Ambulance, 1-1/4 Ton Diesel, M1010, CUCV	9400
D1001	Truck, Ambulance, 4 Litter ARMD, 1-1/4 Ton HMMWV, M997	9900
D1002	Truck, Ambulance, 2 Litter, Soft Top 1-1/4 Ton HMMWV, M1035 .	7500
D1016	Truck, Cargo, 1-1/4 Ton, Diesel M1008, CUCV	8200
D1059	Truck, Cargo, Dropside, 5 Ton, W/O Winch, M923	31800
D1061	Truck, Cargo, XLWB, 5 Ton, W/O Winch, M927	35400
D1072	Truck, Dump, 5 Ton, W/O Winch, M929	34000
D1084	Truck, Firefighting, Brush M530CB	23400
D1085	Truck, Firefighting, Structural M530CS	18800
D1105	Truck, Shelter Carrier Diesel, M1028, CUCV	8700
D1110	Truck, Tank, Fuel, SVC 1200 Gal, W/O Winch, 2-1/2 Ton, M49A2C	19600
D1120	Truck, Tank, Water, 1000 Gal, 2-1/2 Ton, M50A2	19000
D1125	Truck, Tow Carrier, W/O Winch, 1-1/4 Ton, HMMWV, M1045	6300
D1158	Truck, Util, Cargo/Trp Carr, 1-1/4 Ton, HMMWV, M998	7800
D1159	Truck, Util, ARMT Carr, 1-1/4 Ton, HMMWV, M1043	6400
D1160	Truck, Util, 1/4 Ton, M151A2	3000
D1170	Truck, Util, 3/4 Ton, Diesel, M1009, CUCV	6800

Table 4-6 List of USMC Equipment (Cont.)

TAMCN	NOMENCLATURE	MAXIMUM WEIGHT (lb)
D1180	Truck, Util, Shelter Carr, 1-1/4 Ton, HMMWV, M1042	7900
D1190	Truck, Van, 2-1/2 Ton, M109A3	20800
D1212	Truck, Wrecker, 5 Ton, M936	36600
E0640	Howitzer, Light, Towed, 105mm, M101A1	4900
E0663	Howitzer, Medium, SP, 155mm, M109A3	48800
E0665	Howitzer, Medium, Towed, 155mm, M198	15800
E0692	Howitzer, Heavy, SP, 8 in. M110	57600
E0796	Assault Amphibious Vehicle, Command AAVC-7A1	59500
E0846	Assault Amphibious Vehicle, Personnel AAVP-7A1	55100
E0856	Assault Amphibious Vehicle, Recovery AAVR-7A1	66000
E0947	LAV Light Assault Vehicle, 25mm	24000
E1375	Recovery Veh, Full-Track, Light, M578	49300
E1377	Recovery Veh, Full-Track, Med, M88A1	107800
E1875	Tank, Combat, FT, 105mm Gun M60A1 Rise/Pass	107100
E1876	Tank, Combat, FT, W/M9 Bulldozer Kit M60A1	116000
E1888	Main Battle Tank, M1A1 120mm Gun	140000
U3060	Lightweight Amphibious Container Handler	41400

Table 4-7 Debit and Credit Values

	WEIGHT									
FT	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
1	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
2	2000	4000	6000	8000	10000	12000	14000	16000	18000	20000
3	3000	6000	9000	12000	15000	18000	21000	24000	27000	30000
4	4000	8000	12000	16000	20000	24000	28000	32000	36000	40000
5	5000	10000	15000	20000	25000	30000	35000	40000	45000	50000
6	6000	12000	18000	24000	30000	36000	42000	48000	54000	60000
7	7000	14000	21000	28000	35000	42000	49000	56000	63000	70000
8	8000	16000	24000	32000	40000	48000	56000	64000	72000	80000
9	9000	18000	27000	36000	45000	54000	63000	72000	81000	90000

Table 4-7 Debit and Credit Values (Cont.)

	WEIGHT									
FT	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
10	10000	20000	30000	40000	50000	60000	70000	80000	90000	100000
11	11000	22000	33000	44000	55000	66000	77000	88000	99000	110000
12	12000	24000	36000	48000	60000	72000	84000	96000	108000	120000
13	13000	26000	39000	52000	65000	78000	91000	104000	117000	130000
14	14000	28000	42000	56000	70000	84000	98000	112000	126000	140000
15	15000	30000	45000	60000	75000	90000	105000	120000	135000	150000
16	16000	32000	48000	64000	80000	96000	112000	128000	144000	160000
17	17000	34000	51000	68000	85000	102000	119000	136000	153000	170000
18	18000	36000	54000	72000	90000	108000	126000	144000	162000	180000
19	19000	38000	57000	76000	95000	114000	133000	152000	171000	190000
20	20000	40000	60000	80000	100000	120000	140000	160000	180000	200000
21	21000	42000	63000	84000	105000	126000	147000	168000	189000	210000
22	22000	44000	66000	88000	110000	132000	154000	176000	198000	220000
23	23000	46000	69000	92000	115000	138000	161000	184000	207000	230000
24	24000	48000	72000	96000	120000	144000	168000	192000	216000	240000
25	25000	50000	75000	100000	125000	150000	175000	200000	225000	250000
26	26000	52000	78000	104000	130000	156000	182000	208000	234000	260000
27	27000	54000	81000	108000	135000	162000	189000	216000	243000	270000
28	28000	56000	84000	112000	140000	168000	196000	224000	252000	280000
29	29000	58000	87000	116000	145000	174000	203000	232000	261000	290000
30	30000	60000	90000	120000	150000	180000	210000	240000	270000	300000
31	31000	62000	93000	124000	155000	186000	217000	248000	279000	310000
32	32000	64000	96000	128000	160000	192000	224000	256000	288000	320000
33	33000	66000	99000	132000	165000	198000	231000	264000	297000	330000
34	34000	68000	102000	136000	170000	204000	238000	272000	306000	340000
35	35000	70000	105000	140000	175000	210000	245000	280000	315000	350000
36	36000	72000	108000	144000	180000	216000	252000	288000	324000	360000
37	37000	74000	111000	148000	185000	222000	259000	296000	333000	370000
38	38000	76000	114000	152000	190000	228000	266000	304000	342000	380000
39	39000	78000	117000	156000	195000	234000	273000	312000	351000	390000

Table 4-7 Debit and Credit Values (Cont.)

	WEIGHT									
FT	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
40	40000	80000	120000	160000	200000	240000	280000	320000	360000	400000
41	41000	82000	123000	164000	205000	246000	287000	328000	369000	410000

Table 4-8 Debit and Credit Values

	WEIGHT										
FT	11000	12000	13000	14000	15000	16000	17000	18000	19000	20000	21000
1	11000	12000	13000	14000	15000	16000	17000	18000	19000	20000	21000
2	22000	24000	26000	28000	30000	32000	34000	36000	38000	40000	42000
3	33000	36000	39000	42000	45000	48000	51000	54000	57000	60000	63000
4	44000	48000	52000	56000	60000	64000	68000	72000	76000	80000	84000
5	55000	60000	65000	70000	75000	80000	85000	90000	95000	100000	105000
6	66000	72000	78000	84000	90000	96000	102000	108000	114000	120000	126000
7	77000	84000	91000	98000	105000	112000	119000	126000	133000	140000	147000
8	88000	96000	104000	112000	120000	128000	136000	144000	152000	160000	168000
9	99000	108000	117000	126000	135000	144000	153000	162000	171000	180000	189000
10	110000	120000	130000	140000	150000	160000	170000	180000	190000	200000	210000
11	121000	132000	143000	154000	165000	176000	187000	198000	209000	220000	231000
12	132000	144000	156000	168000	180000	192000	204000	216000	228000	240000	252000
13	143000	156000	169000	182000	195000	208000	221000	234000	247000	260000	273000
14	154000	168000	182000	196000	210000	224000	238000	252000	266000	280000	294000
15	165000	180000	195000	210000	225000	240000	255000	270000	285000	300000	315000
16	176000	192000	208000	224000	240000	256000	272000	288000	304000	320000	336000
17	187000	204000	221000	238000	255000	272000	289000	306000	323000	340000	357000
18	198000	216000	234000	252000	270000	288000	306000	324000	342000	360000	378000
19	209000	228000	247000	266000	285000	304000	323000	342000	361000	380000	399000
20	220000	240000	260000	280000	300000	320000	340000	360000	380000	400000	420000
21	231000	252000	273000	294000	315000	336000	357000	378000	399000	420000	441000
22	242000	264000	286000	308000	330000	352000	374000	396000	418000	440000	462000
23	253000	276000	299000	322000	345000	368000	391000	414000	437000	460000	483000
24	264000	288000	312000	336000	360000	384000	408000	432000	456000	480000	504000

Table 4-8 Debit and Credit Values (Cont.)

	WEIGHT										
FT	11000	12000	13000	14000	15000	16000	17000	18000	19000	20000	21000
25	275000	300000	325000	350000	375000	400000	425000	450000	475000	500000	525000
26	286000	312000	338000	364000	390000	416000	442000	468000	494000	520000	546000
27	297000	324000	351000	378000	405000	432000	459000	486000	513000	540000	567000
28	308000	336000	364000	392000	420000	448000	476000	504000	532000	560000	588000
29	319000	348000	377000	406000	435000	464000	493000	522000	551000	580000	609000
30	330000	360000	390000	420000	450000	480000	510000	540000	570000	600000	630000
31	341000	372000	403000	434000	465000	496000	527000	558000	589000	620000	651000
32	352000	384000	416000	448000	480000	512000	544000	576000	608000	640000	672000
33	363000	396000	429000	462000	495000	528000	561000	594000	627000	660000	693000
34	374000	408000	442000	476000	510000	544000	578000	612000	646000	680000	714000
35	385000	420000	455000	490000	525000	560000	595000	630000	665000	700000	735000
36	396000	432000	468000	504000	540000	576000	612000	648000	684000	720000	756000
37	407000	444000	481000	518000	555000	592000	629000	666000	703000	740000	777000
38	418000	456000	494000	532000	570000	608000	646000	684000	722000	760000	798000
39	429000	468000	507000	546000	585000	624000	663000	702000	741000	780000	819000
40	440000	480000	520000	560000	600000	640000	680000	720000	760000	800000	840000
41	451000	492000	533000	574000	615000	656000	697000	738000	779000	820000	861000

Table 4-9 Debit and Credit Values

	WEIGHT										
FT	22000	23000	24000	25000	26000	27000	28000	29000	30000	31000	32000
1	22000	23000	24000	25000	26000	27000	28000	29000	30000	31000	32000
2	44000	46000	48000	50000	52000	54000	56000	58000	60000	62000	64000
3	66000	69000	72000	75000	78000	81000	84000	87000	90000	93000	96000
4	88000	92000	96000	100000	104000	108000	112000	116000	120000	124000	128000
5	110000	115000	120000	125000	130000	135000	140000	145000	150000	155000	160000
6	132000	138000	144000	150000	156000	162000	168000	174000	180000	186000	192000
7	154000	161000	168000	175000	182000	189000	196000	203000	210000	217000	224000
8	176000	184000	192000	200000	208000	216000	224000	232000	240000	248000	256000
9	198000	207000	216000	225000	234000	243000	252000	261000	270000	279000	288000

Table 4-9 Debit and Credit Values (Cont.)

	WEIGHT										
FT	22000	23000	24000	25000	26000	27000	28000	29000	30000	31000	32000
10	220000	230000	240000	250000	260000	270000	280000	290000	300000	310000	320000
11	242000	253000	264000	275000	286000	297000	308000	319000	330000	341000	352000
12	264000	276000	288000	300000	312000	324000	336000	348000	360000	372000	384000
13	286000	299000	312000	325000	338000	351000	364000	377000	390000	403000	416000
14	308000	322000	336000	350000	364000	378000	392000	406000	420000	434000	448000
15	330000	345000	360000	375000	390000	405000	420000	435000	450000	465000	480000
16	352000	368000	384000	400000	416000	432000	448000	464000	480000	496000	512000
17	374000	391000	408000	425000	442000	459000	476000	493000	510000	527000	544000
18	396000	414000	432000	450000	468000	486000	504000	522000	540000	558000	576000
19	418000	437000	456000	475000	494000	513000	532000	551000	570000	589000	608000
20	440000	460000	480000	500000	520000	540000	560000	580000	600000	620000	640000
21	462000	483000	504000	525000	546000	567000	588000	609000	630000	651000	672000
22	484000	506000	528000	550000	572000	594000	616000	638000	660000	682000	704000
23	506000	529000	552000	575000	598000	621000	644000	667000	690000	713000	736000
24	528000	552000	576000	600000	624000	648000	672000	696000	720000	744000	768000
25	550000	575000	600000	625000	650000	675000	700000	725000	750000	775000	800000
26	572000	598000	624000	650000	676000	702000	728000	754000	780000	806000	832000
27	594000	621000	648000	675000	702000	729000	756000	783000	810000	837000	864000
28	616000	644000	672000	700000	728000	756000	784000	812000	840000	868000	896000
29	638000	667000	696000	725000	754000	783000	812000	841000	870000	899000	928000
30	660000	690000	720000	750000	780000	810000	840000	870000	900000	930000	960000
31	682000	713000	744000	775000	806000	837000	868000	899000	930000	961000	992000
32	704000	736000	768000	800000	832000	864000	896000	928000	960000	992000	1024000
33	726000	759000	792000	825000	858000	891000	924000	957000	990000	1023000	1056000
34	748000	782000	816000	850000	884000	918000	952000	986000	1020000	1054000	1088000
35	770000	805000	840000	875000	910000	945000	980000	1015000	1050000	1085000	1120000
36	792000	828000	864000	900000	936000	972000	1008000	1044000	1080000	1116000	1152000
37	814000	851000	888000	925000	962000	999000	1036000	1073000	1110000	1147000	1184000
38	836000	874000	912000	950000	988000	1026000	1064000	1102000	1140000	1178000	1216000
39	858000	897000	936000	975000	1014000	1053000	1092000	1131000	1170000	1209000	1248000

Table 4-9 Debit and Credit Values (Cont.)

	WEIGHT										
FT	22000	23000	24000	25000	26000	27000	28000	29000	30000	31000	32000
40	880000	920000	960000	1000000	1040000	1080000	1120000	1160000	1200000	1240000	1280000
41	902000	943000	984000	1025000	1066000	1107000	1148000	1189000	1230000	1271000	1312000

Table 4-10 Debit and Credit Values

	WEIGHT										
FT	33000	34000	35000	36000	37000	38000	39000	40000	41000	42000	43000
1	33000	34000	35000	36000	37000	38000	39000	40000	41000	42000	43000
2	66000	68000	70000	72000	74000	76000	78000	80000	82000	84000	86000
3	99000	102000	105000	108000	111000	114000	117000	120000	123000	126000	129000
4	132000	136000	140000	144000	148000	152000	156000	160000	164000	168000	172000
5	165000	170000	175000	180000	185000	190000	195000	200000	205000	210000	215000
6	198000	204000	210000	216000	222000	228000	234000	240000	246000	252000	258000
7	231000	238000	245000	252000	259000	266000	273000	280000	287000	294000	301000
8	264000	272000	280000	288000	296000	304000	312000	320000	328000	336000	344000
9	297000	306000	315000	324000	333000	342000	351000	360000	369000	378000	387000
10	330000	340000	350000	360000	370000	380000	390000	400000	410000	420000	430000
11	363000	374000	385000	396000	407000	418000	429000	440000	451000	462000	473000
12	396000	408000	420000	432000	444000	456000	468000	480000	492000	504000	516000
13	429000	442000	455000	468000	481000	494000	507000	520000	533000	546000	559000
14	462000	476000	490000	504000	518000	532000	546000	560000	574000	588000	602000
15	495000	510000	525000	540000	555000	570000	585000	600000	615000	630000	645000
16	528000	544000	560000	576000	592000	608000	624000	640000	656000	672000	688000
17	561000	578000	595000	612000	629000	646000	663000	680000	697000	714000	731000
18	594000	612000	630000	648000	666000	684000	702000	720000	738000	756000	774000
19	627000	646000	665000	684000	703000	722000	741000	760000	779000	798000	817000
20	660000	680000	700000	720000	740000	760000	780000	800000	820000	840000	860000
21	693000	714000	735000	756000	777000	798000	819000	840000	861000	882000	903000
22	726000	748000	770000	792000	814000	836000	858000	880000	902000	924000	946000
23	759000	782000	805000	828000	851000	874000	897000	920000	943000	966000	989000
24	792000	816000	840000	864000	888000	912000	936000	960000	984000	1008000	1032000

Table 4-10 Debit and Credit Values (Cont.)

	WEIGHT										
FT	33000	34000	35000	36000	37000	38000	39000	40000	41000	42000	43000
25	825000	850000	875000	900000	925000	950000	975000	1000000	1025000	1050000	1075000
26	858000	884000	910000	936000	962000	988000	1014000	1040000	1066000	1092000	1118000
27	891000	918000	945000	972000	999000	1026000	1053000	1080000	1107000	1134000	1161000
28	924000	952000	980000	1008000	1036000	1064000	1092000	1120000	1148000	1176000	1204000
29	957000	986000	1015000	1044000	1073000	1102000	1131000	1160000	1189000	1218000	1247000
30	990000	1020000	1050000	1080000	1110000	1140000	1170000	1200000	1230000	1260000	1290000
31	1023000	1054000	1085000	1116000	1147000	1178000	1209000	1240000	1271000	1302000	1333000
32	1056000	1088000	1120000	1152000	1184000	1216000	1248000	1280000	1312000	1344000	1376000
33	1089000	1122000	1155000	1188000	1221000	1254000	1287000	1320000	1353000	1386000	1419000
34	1122000	1156000	1190000	1224000	1258000	1292000	1326000	1360000	1394000	1428000	1462000
35	1155000	1190000	1225000	1260000	1295000	1330000	1365000	1400000	1435000	1470000	1505000
36	1188000	1224000	1260000	1296000	1332000	1368000	1404000	1440000	1476000	1512000	1548000
37	1221000	1258000	1295000	1332000	1369000	1406000	1443000	1480000	1517000	1554000	1591000
38	1254000	1292000	1330000	1368000	1406000	1444000	1482000	1520000	1558000	1596000	1634000
39	1287000	1326000	1365000	1404000	1443000	1482000	1521000	1560000	1599000	1638000	1677000
40	1320000	1360000	1400000	1440000	1480000	1520000	1560000	1600000	1640000	1680000	1720000
41	1353000	1394000	1435000	1476000	1517000	1558000	1599000	1640000	1681000	1722000	1763000

Table 4-11 Debit and Credit Values

	WEIGHT										
FT	44000	45000	46000	47000	48000	49000	50000	51000	52000	53000	54000
1	44000	45000	46000	47000	48000	49000	50000	51000	52000	53000	54000
2	88000	90000	92000	94000	96000	98000	100000	102000	104000	106000	108000
3	132000	135000	138000	141000	144000	147000	150000	153000	156000	159000	162000
4	176000	180000	184000	188000	192000	196000	200000	204000	208000	212000	216000
5	220000	225000	230000	235000	240000	245000	250000	255000	260000	265000	270000
6	264000	270000	276000	282000	288000	294000	300000	306000	312000	318000	324000
7	308000	315000	322000	329000	336000	343000	350000	357000	364000	371000	378000
8	352000	360000	368000	376000	384000	392000	400000	408000	416000	424000	432000
9	396000	405000	414000	423000	432000	441000	450000	459000	468000	477000	486000

Table 4-11 Debit and Credit Values (Cont.)

	WEIGHT										
FT	44000	45000	46000	47000	48000	49000	50000	51000	52000	53000	54000
10	440000	450000	460000	470000	480000	490000	500000	510000	520000	530000	540000
11	484000	495000	506000	517000	528000	539000	550000	561000	572000	583000	594000
12	528000	540000	552000	564000	576000	588000	600000	612000	624000	636000	648000
13	572000	585000	598000	611000	624000	637000	650000	663000	676000	689000	702000
14	616000	630000	644000	658000	672000	686000	700000	714000	728000	742000	756000
15	660000	675000	690000	705000	720000	735000	750000	765000	780000	795000	810000
16	704000	720000	736000	752000	768000	784000	800000	816000	832000	848000	864000
17	748000	765000	782000	799000	816000	833000	850000	867000	884000	901000	918000
18	792000	810000	828000	846000	864000	882000	900000	918000	936000	954000	972000
19	836000	855000	874000	893000	912000	931000	950000	969000	988000	1007000	1026000
20	880000	900000	920000	940000	960000	980000	1000000	1020000	1040000	1060000	1080000
21	924000	945000	966000	987000	1008000	1029000	1050000	1071000	1092000	1113000	1134000
22	968000	990000	1012000	1034000	1056000	1078000	1100000	1122000	1144000	1166000	1188000
23	1012000	1035000	1058000	1081000	1104000	1127000	1150000	1173000	1196000	1219000	1242000
24	1056000	1080000	1104000	1128000	1152000	1176000	1200000	1224000	1248000	1272000	1296000
25	1100000	1125000	1150000	1175000	1200000	1225000	1250000	1275000	1300000	1325000	1350000
26	1144000	1170000	1196000	1222000	1248000	1274000	1300000	1326000	1352000	1378000	1404000
27	1188000	1215000	1242000	1269000	1296000	1323000	1350000	1377000	1404000	1431000	1458000
28	1232000	1260000	1288000	1316000	1344000	1372000	1400000	1428000	1456000	1484000	1512000
29	1276000	1305000	1334000	1363000	1392000	1421000	1450000	1479000	1508000	1537000	1566000
30	1320000	1350000	1380000	1410000	1440000	1470000	1500000	1530000	1560000	1590000	1620000
31	1364000	1395000	1426000	1457000	1488000	1519000	1550000	1581000	1612000	1643000	1674000
32	1408000	1440000	1472000	1504000	1536000	1568000	1600000	1632000	1664000	1696000	1728000
33	1452000	1485000	1518000	1551000	1584000	1617000	1650000	1683000	1716000	1749000	1782000
34	1496000	1530000	1564000	1598000	1632000	1666000	1700000	1734000	1768000	1802000	1836000
35	1540000	1575000	1610000	1645000	1680000	1715000	1750000	1785000	1820000	1855000	1890000
36	1584000	1620000	1656000	1692000	1728000	1764000	1800000	1836000	1872000	1908000	1944000
37	1628000	1665000	1702000	1739000	1776000	1813000	1850000	1887000	1924000	1961000	1998000
38	1672000	1710000	1748000	1786000	1824000	1862000	1900000	1938000	1976000	2014000	2052000
39	1716000	1755000	1794000	1833000	1872000	1911000	1950000	1989000	2028000	2067000	2106000

Table 4-11 Debit and Credit Values (Cont.)

	WEIGHT										
FT	44000	45000	46000	47000	48000	49000	50000	51000	52000	53000	54000
40	1760000	1800000	1840000	1880000	1920000	1960000	2000000	2040000	2080000	2120000	2160000
41	1804000	1845000	1886000	1927000	1968000	2009000	2050000	2091000	2132000	2173000	2214000

Table 4-12 Debit and Credit Values

	WEIGHT										
FT	55000	56000	57000	58000	59000	60000	61000	62000	63000	64000	65000
1	55000	56000	57000	58000	59000	60000	61000	62000	63000	64000	65000
2	110000	112000	114000	116000	118000	120000	122000	124000	126000	128000	130000
3	165000	168000	171000	174000	177000	180000	183000	186000	189000	192000	195000
4	220000	224000	228000	232000	236000	240000	244000	248000	252000	256000	260000
5	275000	280000	285000	290000	295000	300000	305000	310000	315000	320000	325000
6	330000	336000	342000	348000	354000	360000	366000	372000	378000	384000	390000
7	385000	392000	399000	406000	413000	420000	427000	434000	441000	448000	455000
8	440000	448000	456000	464000	472000	480000	488000	496000	504000	512000	520000
9	495000	504000	513000	522000	531000	540000	549000	558000	567000	576000	585000
10	550000	560000	570000	580000	590000	600000	610000	620000	630000	640000	650000
11	605000	616000	627000	638000	649000	660000	671000	682000	693000	704000	715000
12	660000	672000	684000	696000	708000	720000	732000	744000	756000	768000	780000
13	715000	728000	741000	754000	767000	780000	793000	806000	819000	832000	845000
14	770000	784000	798000	812000	826000	840000	854000	868000	882000	896000	910000
15	825000	840000	855000	870000	885000	900000	915000	930000	945000	960000	975000
16	880000	896000	912000	928000	944000	960000	976000	992000	1008000	1024000	1040000
17	935000	952000	969000	986000	1003000	1020000	1037000	1054000	1071000	1088000	1105000
18	990000	1008000	1026000	1044000	1062000	1080000	1098000	1116000	1134000	1152000	1170000
19	1045000	1064000	1083000	1102000	1121000	1140000	1159000	1178000	1197000	1216000	1235000
20	1100000	1120000	1140000	1160000	1180000	1200000	1220000	1240000	1260000	1280000	1300000
21	1155000	1176000	1197000	1218000	1239000	1260000	1281000	1302000	1323000	1344000	1365000
22	1210000	1232000	1254000	1276000	1298000	1320000	1342000	1364000	1386000	1408000	1430000
23	1265000	1288000	1311000	1334000	1357000	1380000	1403000	1426000	1449000	1472000	1495000
24	1320000	1344000	1368000	1392000	1416000	1440000	1464000	1488000	1512000	1536000	1560000

Table 4-12 Debit and Credit Values (Cont.)

	WEIGHT										
FT	55000	56000	57000	58000	59000	60000	61000	62000	63000	64000	65000
25	1375000	1400000	1425000	1450000	1475000	1500000	1525000	1550000	1575000	1600000	1625000
26	1430000	1456000	1482000	1508000	1534000	1560000	1586000	1612000	1638000	1664000	1690000
27	1485000	1512000	1539000	1566000	1593000	1620000	1647000	1674000	1701000	1728000	1755000
28	1540000	1568000	1596000	1624000	1652000	1680000	1708000	1736000	1764000	1792000	1820000
29	1595000	1624000	1653000	1682000	1711000	1740000	1769000	1798000	1827000	1856000	1885000
30	1650000	1680000	1710000	1740000	1770000	1800000	1830000	1860000	1890000	1920000	1950000
31	1705000	1736000	1767000	1798000	1829000	1860000	1891000	1922000	1953000	1984000	2015000
32	1760000	1792000	1824000	1856000	1888000	1920000	1952000	1984000	2016000	2048000	2080000
33	1815000	1848000	1881000	1914000	1947000	1980000	2013000	2046000	2079000	2112000	2145000
34	1870000	1904000	1938000	1972000	2006000	2040000	2074000	2108000	2142000	2176000	2210000
35	1925000	1960000	1995000	2030000	2065000	2100000	2135000	2170000	2205000	2240000	2275000
36	1980000	2016000	2052000	2088000	2124000	2160000	2196000	2232000	2268000	2304000	2340000
37	2035000	2072000	2109000	2146000	2183000	2220000	2257000	2294000	2331000	2368000	2405000
38	2090000	2128000	2166000	2204000	2242000	2280000	2318000	2356000	2394000	2432000	2470000
39	2145000	2184000	2223000	2262000	2301000	2340000	2379000	2418000	2457000	2496000	2535000
40	2200000	2240000	2280000	2320000	2360000	2400000	2440000	2480000	2520000	2560000	2600000
41	2255000	2296000	2337000	2378000	2419000	2460000	2501000	2542000	2583000	2624000	2665000

Table 4-13 Debit and Credit Values

	WEIGHT										
FT	66000	67000	68000	69000	70000	71000	72000	73000	74000	75000	76000
1	66000	67000	68000	69000	70000	71000	72000	73000	74000	75000	76000
2	132000	134000	136000	138000	140000	142000	144000	146000	148000	150000	152000
3	198000	201000	204000	207000	210000	213000	216000	219000	222000	225000	228000
4	264000	268000	272000	276000	280000	284000	288000	292000	296000	300000	304000
5	330000	335000	340000	345000	350000	355000	360000	365000	370000	375000	380000
6	396000	402000	408000	414000	420000	426000	432000	438000	444000	450000	456000
7	462000	469000	476000	483000	490000	497000	504000	511000	518000	525000	532000
8	528000	536000	544000	552000	560000	568000	576000	584000	592000	600000	608000
9	594000	603000	612000	621000	630000	639000	648000	657000	666000	675000	684000

Table 4-13 Debit and Credit Values (Cont.)

	WEIGHT										
FT	66000	67000	68000	69000	70000	71000	72000	73000	74000	75000	76000
10	660000	670000	680000	690000	700000	710000	720000	730000	740000	750000	760000
11	726000	737000	748000	759000	770000	781000	792000	803000	814000	825000	836000
12	792000	804000	816000	828000	840000	852000	864000	876000	888000	900000	912000
13	858000	871000	884000	897000	910000	923000	936000	949000	962000	975000	988000
14	924000	938000	952000	966000	980000	994000	1008000	1022000	1036000	1050000	1064000
15	990000	1005000	1020000	1035000	1050000	1065000	1080000	1095000	1110000	1125000	1140000
16	1056000	1072000	1088000	1104000	1120000	1136000	1152000	1168000	1184000	1200000	1216000
17	1122000	1139000	1156000	1173000	1190000	1207000	1224000	1241000	1258000	1275000	1292000
18	1188000	1206000	1224000	1242000	1260000	1278000	1296000	1314000	1332000	1350000	1368000
19	1254000	1273000	1292000	1311000	1330000	1349000	1368000	1387000	1406000	1425000	1444000
20	1320000	1340000	1360000	1380000	1400000	1420000	1440000	1460000	1480000	1500000	1520000
21	1386000	1407000	1428000	1449000	1470000	1491000	1512000	1533000	1554000	1575000	1596000
22	1452000	1474000	1496000	1518000	1540000	1562000	1584000	1606000	1628000	1650000	1672000
23	1518000	1541000	1564000	1587000	1610000	1633000	1656000	1679000	1702000	1725000	1748000
24	1584000	1608000	1632000	1656000	1680000	1704000	1728000	1752000	1776000	1800000	1824000
25	1650000	1675000	1700000	1725000	1750000	1775000	1800000	1825000	1850000	1875000	1900000
26	1716000	1742000	1768000	1794000	1820000	1846000	1872000	1898000	1924000	1950000	1976000
27	1782000	1809000	1836000	1863000	1890000	1917000	1944000	1971000	1998000	2025000	2052000
28	1848000	1876000	1904000	1932000	1960000	1988000	2016000	2044000	2072000	2100000	2128000
29	1914000	1943000	1972000	2001000	2030000	2059000	2088000	2117000	2146000	2175000	2204000
30	1980000	2010000	2040000	2070000	2100000	2130000	2160000	2190000	2220000	2250000	2280000
31	2046000	2077000	2108000	2139000	2170000	2201000	2232000	2263000	2294000	2325000	2356000
32	2112000	2144000	2176000	2208000	2240000	2272000	2304000	2336000	2368000	2400000	2432000
33	2178000	2211000	2244000	2277000	2310000	2343000	2376000	2409000	2442000	2475000	2508000
34	2244000	2278000	2312000	2346000	2380000	2414000	2448000	2482000	2516000	2550000	2584000
35	2310000	2345000	2380000	2415000	2450000	2485000	2520000	2555000	2590000	2625000	2660000
36	2376000	2412000	2448000	2484000	2520000	2556000	2592000	2628000	2664000	2700000	2736000
37	2442000	2479000	2516000	2553000	2590000	2627000	2664000	2701000	2738000	2775000	2812000
38	2508000	2546000	2584000	2622000	2660000	2698000	2736000	2774000	2812000	2850000	2888000
39	2574000	2613000	2652000	2691000	2730000	2769000	2808000	2847000	2886000	2925000	2964000

Table 4-13 Debit and Credit Values (Cont.)

	WEIGHT										
FT	66000	67000	68000	69000	70000	71000	72000	73000	74000	75000	76000
40	2640000	2680000	2720000	2760000	2800000	2840000	2880000	2920000	2960000	3000000	3040000
41	2706000	2747000	2788000	2829000	2870000	2911000	2952000	2993000	3034000	3075000	3116000

Table 4-14 Debit and Credit Values

	WEIGHT										
FT	77000	78000	79000	80000	81000	82000	83000	84000	85000	86000	87000
1	77000	78000	79000	80000	81000	82000	83000	84000	85000	86000	87000
2	154000	156000	158000	160000	162000	164000	166000	168000	170000	172000	174000
3	231000	234000	237000	240000	243000	246000	249000	252000	255000	258000	261000
4	308000	312000	316000	320000	324000	328000	332000	336000	340000	344000	348000
5	385000	390000	395000	400000	405000	410000	415000	420000	425000	430000	435000
6	462000	468000	474000	480000	486000	492000	498000	504000	510000	516000	522000
7	539000	546000	553000	560000	567000	574000	581000	588000	595000	602000	609000
8	616000	624000	632000	640000	648000	656000	664000	672000	680000	688000	696000
9	693000	702000	711000	720000	729000	738000	747000	756000	765000	774000	783000
10	770000	780000	790000	800000	810000	820000	830000	840000	850000	860000	870000
11	847000	858000	869000	880000	891000	902000	913000	924000	935000	946000	957000
12	924000	936000	948000	960000	972000	984000	996000	1008000	1020000	1032000	1044000
13	1001000	1014000	1027000	1040000	1053000	1066000	1079000	1092000	1105000	1118000	1131000
14	1078000	1092000	1106000	1120000	1134000	1148000	1162000	1176000	1190000	1204000	1218000
15	1155000	1170000	1185000	1200000	1215000	1230000	1245000	1260000	1275000	1290000	1305000
16	1232000	1248000	1264000	1280000	1296000	1312000	1328000	1344000	1360000	1376000	1392000
17	1309000	1326000	1343000	1360000	1377000	1394000	1411000	1428000	1445000	1462000	1479000
18	1386000	1404000	1422000	1440000	1458000	1476000	1494000	1512000	1530000	1548000	1566000
19	1463000	1482000	1501000	1520000	1539000	1558000	1577000	1596000	1615000	1634000	1653000
20	1540000	1560000	1580000	1600000	1620000	1640000	1660000	1680000	1700000	1720000	1740000
21	1617000	1638000	1659000	1680000	1701000	1722000	1743000	1764000	1785000	1806000	1827000
22	1694000	1716000	1738000	1760000	1782000	1804000	1826000	1848000	1870000	1892000	1914000
23	1771000	1794000	1817000	1840000	1863000	1886000	1909000	1932000	1955000	1978000	2001000
24	1848000	1872000	1896000	1920000	1944000	1968000	1992000	2016000	2040000	2064000	2088000

Table 4-14 Debit and Credit Values (Cont.)

	WEIGHT										
FT	77000	78000	79000	80000	81000	82000	83000	84000	85000	86000	87000
25	1925000	1950000	1975000	2000000	2025000	2050000	2075000	2100000	2125000	2150000	2175000
26	2002000	2028000	2054000	2080000	2106000	2132000	2158000	2184000	2210000	2236000	2262000
27	2079000	2106000	2133000	2160000	2187000	2214000	2241000	2268000	2295000	2322000	2349000
28	2156000	2184000	2212000	2240000	2268000	2296000	2324000	2352000	2380000	2408000	2436000
29	2233000	2262000	2291000	2320000	2349000	2378000	2407000	2436000	2465000	2494000	2523000
30	2310000	2340000	2370000	2400000	2430000	2460000	2490000	2520000	2550000	2580000	2610000
31	2387000	2418000	2449000	2480000	2511000	2542000	2573000	2604000	2635000	2666000	2697000
32	2464000	2496000	2528000	2560000	2592000	2624000	2656000	2688000	2720000	2752000	2784000
33	2541000	2574000	2607000	2640000	2673000	2706000	2739000	2772000	2805000	2838000	2871000
34	2618000	2652000	2686000	2720000	2754000	2788000	2822000	2856000	2890000	2924000	2958000
35	2695000	2730000	2765000	2800000	2835000	2870000	2905000	2940000	2975000	3010000	3045000
36	2772000	2808000	2844000	2880000	2916000	2952000	2988000	3024000	3060000	3096000	3132000
37	2849000	2886000	2923000	2960000	2997000	3034000	3071000	3108000	3145000	3182000	3219000
38	2926000	2964000	3002000	3040000	3078000	3116000	3154000	3192000	3230000	3268000	3306000
39	3003000	3042000	3081000	3120000	3159000	3198000	3237000	3276000	3315000	3354000	3393000
40	3080000	3120000	3160000	3200000	3240000	3280000	3320000	3360000	3400000	3440000	3480000
41	3157000	3198000	3239000	3280000	3321000	3362000	3403000	3444000	3485000	3526000	3567000

Table 4-15 Debit and Credit Values

	WEIGHT										
FT	88000	89000	90000	91000	92000	93000	94000	95000	96000	97000	98000
1	88000	89000	90000	91000	92000	93000	94000	95000	96000	97000	98000
2	176000	178000	180000	182000	184000	186000	188000	190000	192000	194000	196000
3	264000	267000	270000	273000	276000	279000	282000	285000	288000	291000	294000
4	352000	356000	360000	364000	368000	372000	376000	380000	384000	388000	392000
5	440000	445000	450000	455000	460000	465000	470000	475000	480000	485000	490000
6	528000	534000	540000	546000	552000	558000	564000	570000	576000	582000	588000
7	616000	623000	630000	637000	644000	651000	658000	665000	672000	679000	686000
8	704000	712000	720000	728000	736000	744000	752000	760000	768000	776000	784000
9	792000	801000	810000	819000	828000	837000	846000	855000	864000	873000	882000

Table 4-15 Debit and Credit Values (Cont.)

	WEIGHT										
FT	88000	89000	90000	91000	92000	93000	94000	95000	96000	97000	98000
10	880000	890000	900000	910000	920000	930000	940000	950000	960000	970000	980000
11	968000	979000	990000	1001000	1012000	1023000	1034000	1045000	1056000	1067000	1078000
12	1056000	1068000	1080000	1092000	1104000	1116000	1128000	1140000	1152000	1164000	1176000
13	1144000	1157000	1170000	1183000	1196000	1209000	1222000	1235000	1248000	1261000	1274000
14	1232000	1246000	1260000	1274000	1288000	1302000	1316000	1330000	1344000	1358000	1372000
15	1320000	1335000	1350000	1365000	1380000	1395000	1410000	1425000	1440000	1455000	1470000
16	1408000	1424000	1440000	1456000	1472000	1488000	1504000	1520000	1536000	1552000	1568000
17	1496000	1513000	1530000	1547000	1564000	1581000	1598000	1615000	1632000	1649000	1666000
18	1584000	1602000	1620000	1638000	1656000	1674000	1692000	1710000	1728000	1746000	1764000
19	1672000	1691000	1710000	1729000	1748000	1767000	1786000	1805000	1824000	1843000	1862000
20	1760000	1780000	1800000	1820000	1840000	1860000	1880000	1900000	1920000	1940000	1960000
21	1848000	1869000	1890000	1911000	1932000	1953000	1974000	1995000	2016000	2037000	2058000
22	1936000	1958000	1980000	2002000	2024000	2046000	2068000	2090000	2112000	2134000	2156000
23	2024000	2047000	2070000	2093000	2116000	2139000	2162000	2185000	2208000	2231000	2254000
24	2112000	2136000	2160000	2184000	2208000	2232000	2256000	2280000	2304000	2328000	2352000
25	2200000	2225000	2250000	2275000	2300000	2325000	2350000	2375000	2400000	2425000	2450000
26	2288000	2314000	2340000	2366000	2392000	2418000	2444000	2470000	2496000	2522000	2548000
27	2376000	2403000	2430000	2457000	2484000	2511000	2538000	2565000	2592000	2619000	2646000
28	2464000	2492000	2520000	2548000	2576000	2604000	2632000	2660000	2688000	2716000	2744000
29	2552000	2581000	2610000	2639000	2668000	2697000	2726000	2755000	2784000	2813000	2842000
30	2640000	2670000	2700000	2730000	2760000	2790000	2820000	2850000	2880000	2910000	2940000
31	2728000	2759000	2790000	2821000	2852000	2883000	2914000	2945000	2976000	3007000	3038000
32	2816000	2848000	2880000	2912000	2944000	2976000	3008000	3040000	3072000	3104000	3136000
33	2904000	2937000	2970000	3003000	3036000	3069000	3102000	3135000	3168000	3201000	3234000
34	2992000	3026000	3060000	3094000	3128000	3162000	3196000	3230000	3264000	3298000	3332000
35	3080000	3115000	3150000	3185000	3220000	3255000	3290000	3325000	3360000	3395000	3430000
36	3168000	3204000	3240000	3276000	3312000	3348000	3384000	3420000	3456000	3492000	3528000
37	3256000	3293000	3330000	3367000	3404000	3441000	3478000	3515000	3552000	3589000	3626000
38	3344000	3382000	3420000	3458000	3496000	3534000	3572000	3610000	3648000	3686000	3724000
39	3432000	3471000	3510000	3549000	3588000	3627000	3666000	3705000	3744000	3783000	3822000

Table 4-15 Debit and Credit Values (Cont.)

	WEIGHT										
FT	88000	89000	90000	91000	92000	93000	94000	95000	96000	97000	98000
40	3520000	3560000	3600000	3640000	3680000	3720000	3760000	3800000	3840000	3880000	3920000
41	3608000	3649000	3690000	3731000	3772000	3813000	3854000	3895000	3936000	3977000	4018000

Table 4-16 Debit and Credit Values

	WEIGHT										
FT	99000	100000	101000	102000	103000	104000	105000	106000	107000	108000	109000
1	99000	100000	101000	102000	103000	104000	105000	106000	107000	108000	109000
2	198000	200000	202000	204000	206000	208000	210000	212000	214000	216000	218000
3	297000	300000	303000	306000	309000	312000	315000	318000	321000	324000	327000
4	396000	400000	404000	408000	412000	416000	420000	424000	428000	432000	436000
5	495000	500000	505000	510000	515000	520000	525000	530000	535000	540000	545000
6	594000	600000	606000	612000	618000	624000	630000	636000	642000	648000	654000
7	693000	700000	707000	714000	721000	728000	735000	742000	749000	756000	763000
8	792000	800000	808000	816000	824000	832000	840000	848000	856000	864000	872000
9	891000	900000	909000	918000	927000	936000	945000	954000	963000	972000	981000
10	990000	1000000	1010000	1020000	1030000	1040000	1050000	1060000	1070000	1080000	1090000
11	1089000	1100000	1111000	1122000	1133000	1144000	1155000	1166000	1177000	1188000	1199000
12	1188000	1200000	1212000	1224000	1236000	1248000	1260000	1272000	1284000	1296000	1308000
13	1287000	1300000	1313000	1326000	1339000	1352000	1365000	1378000	1391000	1404000	1417000
14	1386000	1400000	1414000	1428000	1442000	1456000	1470000	1484000	1498000	1512000	1526000
15	1485000	1500000	1515000	1530000	1545000	1560000	1575000	1590000	1605000	1620000	1635000
16	1584000	1600000	1616000	1632000	1648000	1664000	1680000	1696000	1712000	1728000	1744000
17	1683000	1700000	1717000	1734000	1751000	1768000	1785000	1802000	1819000	1836000	1853000
18	1782000	1800000	1818000	1836000	1854000	1872000	1890000	1908000	1926000	1944000	1962000
19	1881000	1900000	1919000	1938000	1957000	1976000	1995000	2014000	2033000	2052000	2071000
20	1980000	2000000	2020000	2040000	2060000	2080000	2100000	2120000	2140000	2160000	2180000
21	2079000	2100000	2121000	2142000	2163000	2184000	2205000	2226000	2247000	2268000	2289000
22	2178000	2200000	2222000	2244000	2266000	2288000	2310000	2332000	2354000	2376000	2398000
23	2277000	2300000	2323000	2346000	2369000	2392000	2415000	2438000	2461000	2484000	2507000
24	2376000	2400000	2424000	2448000	2472000	2496000	2520000	2544000	2568000	2592000	2616000

Table 4-16 Debit and Credit Values (Cont.)

	WEIGHT										
FT	99000	100000	101000	102000	103000	104000	105000	106000	107000	108000	109000
25	2475000	2500000	2525000	2550000	2575000	2600000	2625000	2650000	2675000	2700000	2725000
26	2574000	2600000	2626000	2652000	2678000	2704000	2730000	2756000	2782000	2808000	2834000
27	2673000	2700000	2727000	2754000	2781000	2808000	2835000	2862000	2889000	2916000	2943000
28	2772000	2800000	2828000	2856000	2884000	2912000	2940000	2968000	2996000	3024000	3052000
29	2871000	2900000	2929000	2958000	2987000	3016000	3045000	3074000	3103000	3132000	3161000
30	2970000	3000000	3030000	3060000	3090000	3120000	3150000	3180000	3210000	3240000	3270000
31	3069000	3100000	3131000	3162000	3193000	3224000	3255000	3286000	3317000	3348000	3379000
32	3168000	3200000	3232000	3264000	3296000	3328000	3360000	3392000	3424000	3456000	3488000
33	3267000	3300000	3333000	3366000	3399000	3432000	3465000	3498000	3531000	3564000	3597000
34	3366000	3400000	3434000	3468000	3502000	3536000	3570000	3604000	3638000	3672000	3706000
35	3465000	3500000	3535000	3570000	3605000	3640000	3675000	3710000	3745000	3780000	3815000
36	3564000	3600000	3636000	3672000	3708000	3744000	3780000	3816000	3852000	3888000	3924000
37	3663000	3700000	3737000	3774000	3811000	3848000	3885000	3922000	3959000	3996000	4033000
38	3762000	3800000	3838000	3876000	3914000	3952000	3990000	4028000	4066000	4104000	4142000
39	3861000	3900000	3939000	3978000	4017000	4056000	4095000	4134000	4173000	4212000	4251000
40	3960000	4000000	4040000	4080000	4120000	4160000	4200000	4240000	4280000	4320000	4360000
41	4059000	4100000	4141000	4182000	4223000	4264000	4305000	4346000	4387000	4428000	4469000

Table 4-17 Debit and Credit Values

	WEIGHT										
FT	110000	111000	112000	113000	114000	115000	116000	117000	118000	119000	120000
1	110000	111000	112000	113000	114000	115000	116000	117000	118000	119000	120000
2	220000	222000	224000	226000	228000	230000	232000	234000	236000	238000	240000
3	330000	333000	336000	339000	342000	345000	348000	351000	354000	357000	360000
4	440000	444000	448000	452000	456000	460000	464000	468000	472000	476000	480000
5	550000	555000	560000	565000	570000	575000	580000	585000	590000	595000	600000
6	660000	666000	672000	678000	684000	690000	696000	702000	708000	714000	720000
7	770000	777000	784000	791000	798000	805000	812000	819000	826000	833000	840000
8	880000	888000	896000	904000	912000	920000	928000	936000	944000	952000	960000
9	990000	999000	1008000	1017000	1026000	1035000	1044000	1053000	1062000	1071000	1080000

Table 4-17 Debit and Credit Values (Cont.)

	WEIGHT										
FT	110000	111000	112000	113000	114000	115000	116000	117000	118000	119000	120000
10	1100000	1110000	1120000	1130000	1140000	1150000	1160000	1170000	1180000	1190000	1200000
11	1210000	1221000	1232000	1243000	1254000	1265000	1276000	1287000	1298000	1309000	1320000
12	1320000	1332000	1344000	1356000	1368000	1380000	1392000	1404000	1416000	1428000	1440000
13	1430000	1443000	1456000	1469000	1482000	1495000	1508000	1521000	1534000	1547000	1560000
14	1540000	1554000	1568000	1582000	1596000	1610000	1624000	1638000	1652000	1666000	1680000
15	1650000	1665000	1680000	1695000	1710000	1725000	1740000	1755000	1770000	1785000	1800000
16	1760000	1776000	1792000	1808000	1824000	1840000	1856000	1872000	1888000	1904000	1920000
17	1870000	1887000	1904000	1921000	1938000	1955000	1972000	1989000	2006000	2023000	2040000
18	1980000	1998000	2016000	2034000	2052000	2070000	2088000	2106000	2124000	2142000	2160000
19	2090000	2109000	2128000	2147000	2166000	2185000	2204000	2223000	2242000	2261000	2280000
20	2200000	2220000	2240000	2260000	2280000	2300000	2320000	2340000	2360000	2380000	2400000
21	2310000	2331000	2352000	2373000	2394000	2415000	2436000	2457000	2478000	2499000	2520000
22	2420000	2442000	2464000	2486000	2508000	2530000	2552000	2574000	2596000	2618000	2640000
23	2530000	2553000	2576000	2599000	2622000	2645000	2668000	2691000	2714000	2737000	2760000
24	2640000	2664000	2688000	2712000	2736000	2760000	2784000	2808000	2832000	2856000	2880000
25	2750000	2775000	2800000	2825000	2850000	2875000	2900000	2925000	2950000	2975000	3000000
26	2860000	2886000	2912000	2938000	2964000	2990000	3016000	3042000	3068000	3094000	3120000
27	2970000	2997000	3024000	3051000	3078000	3105000	3132000	3159000	3186000	3213000	3240000
28	3080000	3108000	3136000	3164000	3192000	3220000	3248000	3276000	3304000	3332000	3360000
29	3190000	3219000	3248000	3277000	3306000	3335000	3364000	3393000	3422000	3451000	3480000
30	3300000	3330000	3360000	3390000	3420000	3450000	3480000	3510000	3540000	3570000	3600000
31	3410000	3441000	3472000	3503000	3534000	3565000	3596000	3627000	3658000	3689000	3720000
32	3520000	3552000	3584000	3616000	3648000	3680000	3712000	3744000	3776000	3808000	3840000
33	3630000	3663000	3696000	3729000	3762000	3795000	3828000	3861000	3894000	3927000	3960000
34	3740000	3774000	3808000	3842000	3876000	3910000	3944000	3978000	4012000	4046000	4080000
35	3850000	3885000	3920000	3955000	3990000	4025000	4060000	4095000	4130000	4165000	4200000
36	3960000	3996000	4032000	4068000	4104000	4140000	4176000	4212000	4248000	4284000	4320000
37	4070000	4107000	4144000	4181000	4218000	4255000	4292000	4329000	4366000	4403000	4440000
38	4180000	4218000	4256000	4294000	4332000	4370000	4408000	4446000	4484000	4522000	4560000
39	4290000	4329000	4368000	4407000	4446000	4485000	4524000	4563000	4602000	4641000	4680000

Table 4-17 Debit and Credit Values (Cont.)

	WEIGHT										
FT	110000	111000	112000	113000	114000	115000	116000	117000	118000	119000	120000
40	4400000	4440000	4480000	4520000	4560000	4600000	4640000	4680000	4720000	4760000	4800000
41	4510000	4551000	4592000	4633000	4674000	4715000	4756000	4797000	4838000	4879000	4920000

[illegible]

Figure 4-9 LCAC Cargo Load Plan

- c. Placement for Single Item of Cargo. For a single item of cargo, such as, a tank, or other high weight vehicle or high volume piece of cargo it is not necessary to calculate the debit and credit values. In this case, simply place the CG of the vehicle or cargo over the intersection of the cargo LCG and TCG point. When the crew position is used, it will provide a credit value above 10,000. However, fuel transfer may be used to balance the craft under these conditions.
- d. CG of Craft Location for Crew, Passengers, and Cold Weather Kit. Correct weight and balance of all cargo must be included in the load planning process to get correct LCAC weight and balance. While procedures for loading the cargo deck are covered separately, there are three items which increase the weight of the craft and affect balance, for which fixed CG locations are known. These three items are crew, passengers, and the craft cold weather kit. These positions have already been identified and are listed in Table 4-18. The LCG position is listed in feet from the FP and are marked on the cargo deck worksheet. The TCG location which is listed in inches from centerline is provided for information only and is not used in the debit and credit process. Crew and passengers weights will vary for each load while the cold weather kit weighs 2,600 pounds. The data in Table 4-18 should be used to calculate the debit and credit values for the crew, passengers and the cold weather kit.

Table 4-18 Fixed CG Locations for Crew, Passengers, and Cold Weather Kit

	LCG (AFT OF FP)	TCG (FROM CENTERLINE)	WEIGHT
Crew	16 feet	35 inches stbd	Variable (5 man crew 1000 lb)
Passenger	18 feet	212 inches port	Variable
Cold Weather Kit	52 feet	6 inches stbd	2600 lbs

4-2.8.4. **Sample Load Problem For Multiple Cargo Items:** Load (2) D1059 5-ton trucks with (2) E0640 105 towed howitzers, (2) D1158 HMMWV and 1 B2565 forklift.

- a. STEP 1. Determine total cargo weight and CG of all cargo. See Table 4-19

Table 4-19 Sample Load Problem For Multiple Cargo Items

Number	Item	Weight	CG
2	D1059	2 x 31800 = 63600 lbs	123" from front axle
2	E0640	2 x 4900 = 9800 lbs	180" aft of lunette
2	D1158	2 x 7900 = 15600 lbs	84" front axle (loaded)
1	B2565	1 x 8200 = 8200 lbs	47" from front axle
5	Crew	5 x 200 = 1000 lbs	16' aft of FP
		Total Cargo Weight = 98200 lbs	

- b. STEP 2. Determine lightship weight, LCG and TCG (from craft log). See Table 4-20

Table 4-20 Sample: Determine Lightship Weight, LCG and TCG

LCAC	Weight	LCG	TCG
64	205700 lbs	501"	6" stbd

- c. STEP 3. Determine Longitudinal and Transverse Cargo Load Centers. Refer to Figure Table 4-21.

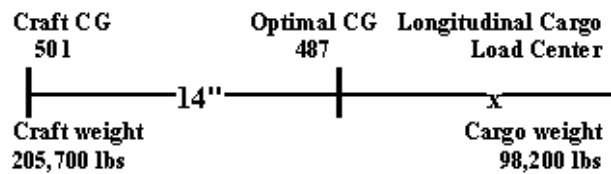


Table 4-21 Calculate Values

Calculations		
205700 x 14	=	(X)98200
2879800	=	98200X
29.3	=	X
or		
29	=	X

Longitudinal cargo load center is $487 - 29 = 458$

Converted to feet, 458 inches - 38.17 feet or 38 feet

Mark cargo deck worksheet at 38 feet aft of FP

NOTE

Transverse Cargo Load Center is not calculated due to the large cargo load size leaving no room for movement.

- d. STEP 4. Spot cargo on the cargo deck worksheet, keeping track of debits and credits while ensuring the cargo can be properly restrained.

NOTE

Prior to loading an LCAC, the loadmaster should make a tentative plan for location of cargo on the cargo deck to ensure it will fit and can be loaded. If adjustments are required, they should be made before calculating, debit and credit values. The final location of cargo may have to be adjusted to get the debit and credit values equal to 0 or slightly positive, but not more than +10,000.

Using the above process, the (2) D1059 5-ton trucks with attached (2) E0640 105 towed howitzers are placed in the port and starboard lanes (facing forward). The remaining, (3) vehicles will be placed in the center lane in the following order: (1) D1158 HMMWV (facing aft) in the aft portion of the lane, (1) B2565 forklift (facing forward) in the center of the center lane and the other (1) D1158 HMMWV (facing forward) in the forward portion of the lane. Since the load fits on the deck and can be properly restrained and all vehicle CGs are known, the exact placement can now be made and debit and credit values calculated.

1. The fixed crew location CG is spotted first.
 - The cargo deck worksheet is marked with the crew weight of the fixed crew location and the debit/credit is determined from the table and listed as shown in Plan View 1 Figure 4-10.
2. The two pairs of D1059 trucks and E0640 Howitzers are spotted next in the outboard lanes.
 - The initial spotting locations of the trucks are shown to be 5 feet forward of the Longitudinal Cargo Load Center. Since the trucks are towing the Howitzers their location has now been determined as well, see Plan View 2 Figure 4-11.
3. The 3 remaining vehicles are going to be spotted in the center lane.

NOTE

A rough estimate of the total length of the three vehicles shows that one of them must be spotted forward of the Longitudinal Cargo Load Center. This will increase the credits of the load so the other two vehicles should be spaced far enough aft of the cargo load center to reduce the credits to near zero.

- One of the 2 HMMWV's is spotted with its CG 25 feet aft of the Longitudinal Cargo Load Center, as shown in Plan View 3 Figure 4-12.
4. The second of the 2 HMMWV's is spotted forward of the Longitudinal Cargo Load Center to create a positive number of credits so the final item (forklift) will be able to balance the load as shown in Plan View 4 Figure 4-13.

5. The final vehicle to be spotted is the forklift. A debit of 42,000 is required to balance the load. Looking down the 8,000 pound (forklift weight) column, a 42,000 debit is not there, the closest debit is 40,000 which would produce a total of +2,000 credits which is within the acceptable range. The 40,000 debit is read over to the end of the row to locate the correct spotting distance which is determined to be 5 ft, see Plan View 5 Figure 4-14.
- e. STEP 5. Total all debits and credits on the sample LCAC cargo load plan (Figure 4-15). Ensure the sum of all debits and credits is equal to 0 or slightly positive (+10,000 or less).
- f. STEP 6. Use the completed cargo deck worksheet to spot the vehicles on the craft. Once the craft is loaded, add the cargo deck worksheet to your file of cargo layouts.
- g. While this completes the loading process, it should be pointed out that it is a repetitive process. Therefore, it is necessary to spot the cargo and figure the debits and credits and then respot and refigure the debits and credits until the load is balanced. For this load, a TCG value was not calculated, due to space restrictions prevent offsetting this cargo to the port side. Therefore, if transverse craft balancing is required it must be accomplished with fuel transfer. For heavy single vehicle loads such as tanks, TCG balancing of the load should be completed.

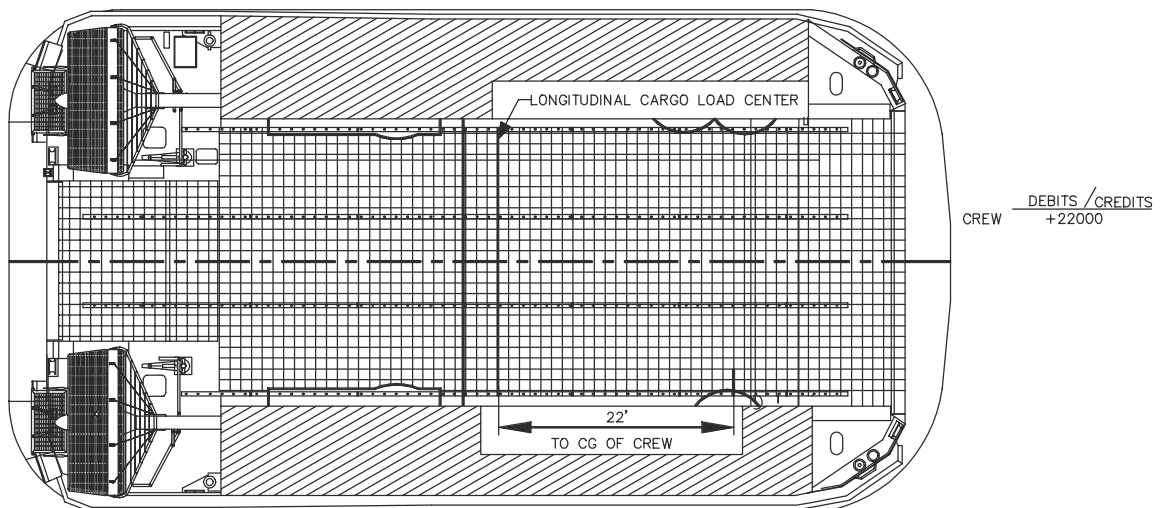


Figure 4-10 Plan View 1

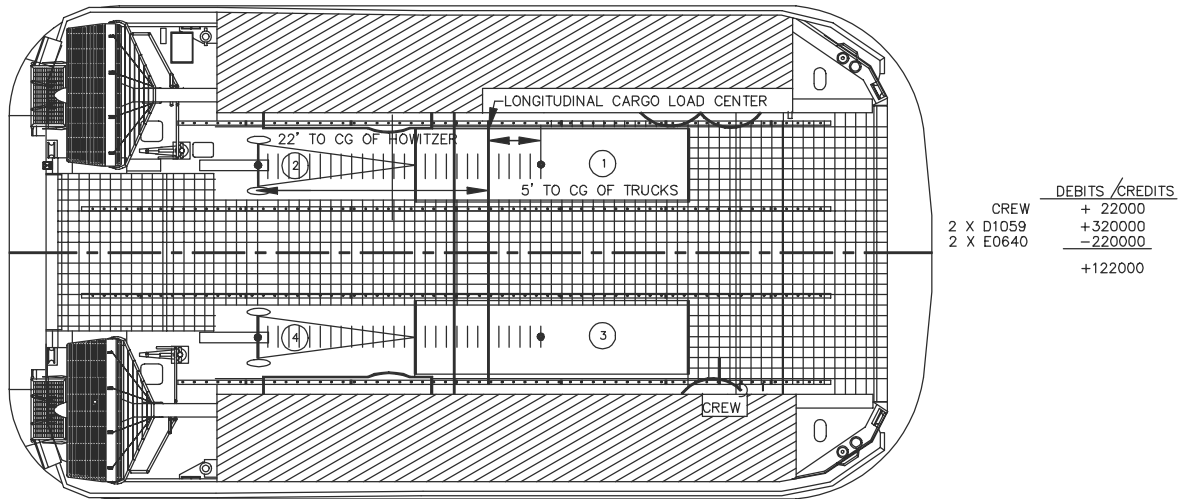


Figure 4-11 Plan View 2

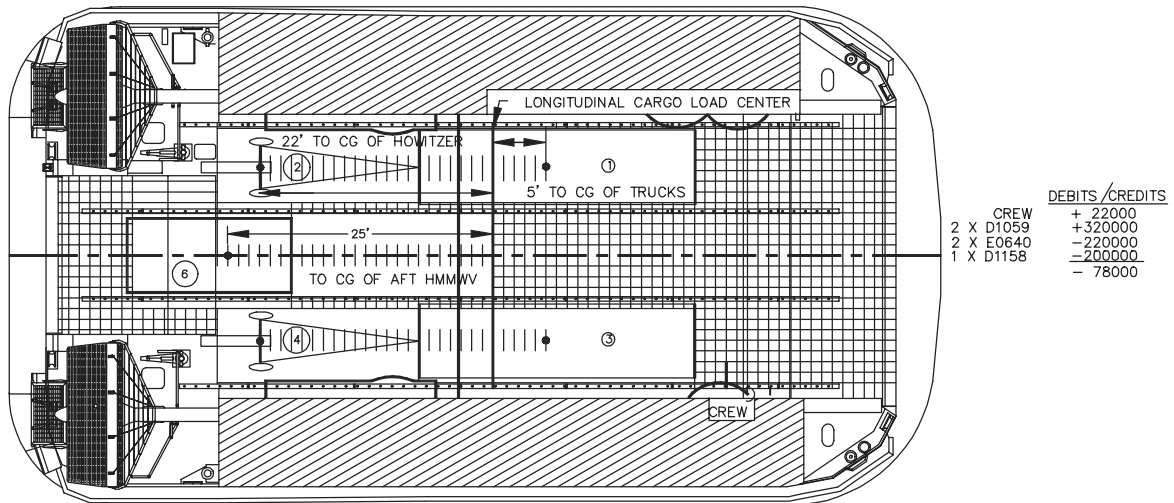


Figure 4-12 Plan View 3

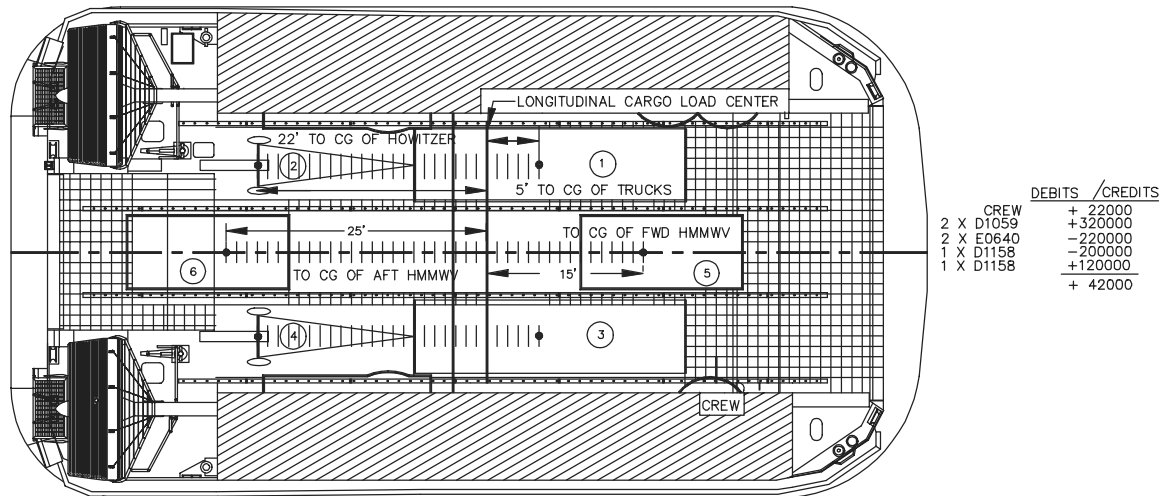


Figure 4-13 Plan View 4

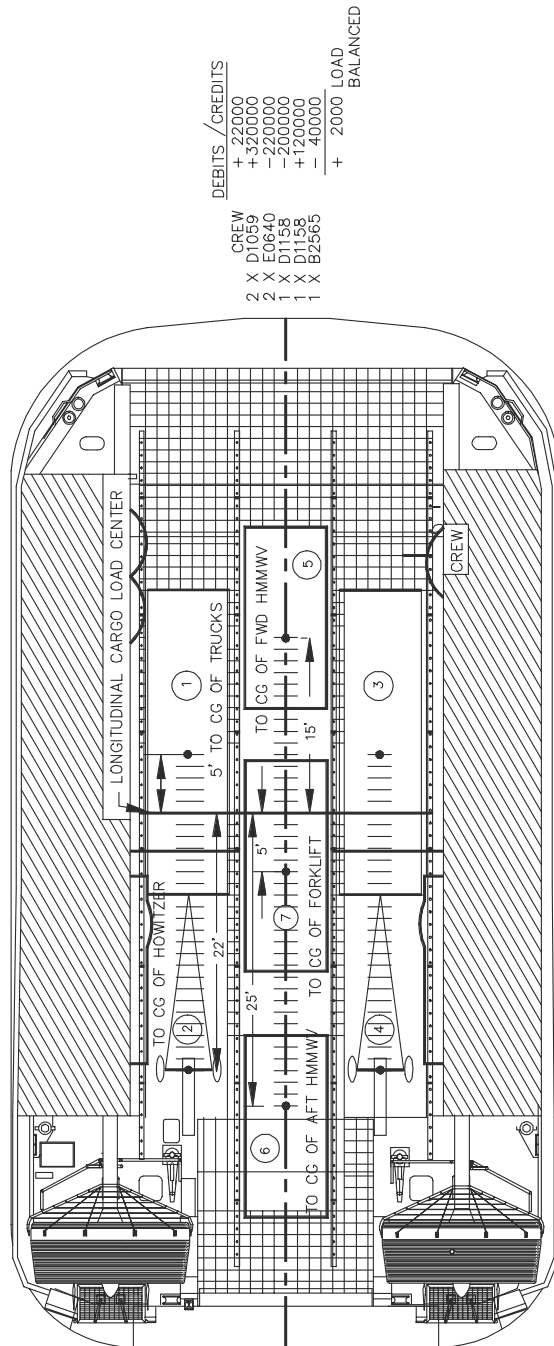


Figure 4-14 Plan View 5

Figure 4-15 Sample LCAC Cargo Load Plan (Multiple Vehicles)

* Fill in only if cargo is other than C.

4-2.8.5. Sample Load Problem For Single Cargo Item: Load (1) E1888 main battle tank.

- a. STEP 1. Determine total cargo weight and CG of all cargo, Refer to Table 4-22

Table 4-22 Sample - Determine Total Cargo Weight and CG of All Cargo

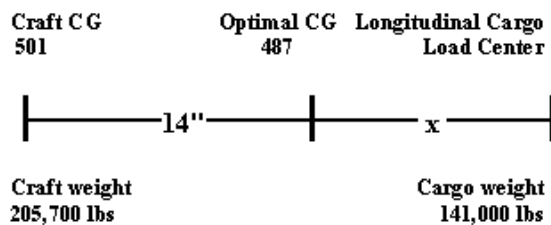
Number	Item	Weight			CG
2	E1888	1 x 140000	=	140000 lbs	126" from front slope
5	Crew	5 x 200	=	1000 lbs	16 ft aft of FP
Total Cargo Weight = 141000 lbs					

- b. STEP 2. Determine lightship weight, LCG and TCG (from craft log). Refer to Table 4-23

Table 4-23 Sample - Determine Lightship Weight, LCG and TCG (from Craft Log)

LCAC	Weight	LCG	TCG
64	205700 lbs	501"	6" stbd

- c. STEP 3. Determine Longitudinal and Transverse Cargo Load Centers.



Refer to Table 4-24.

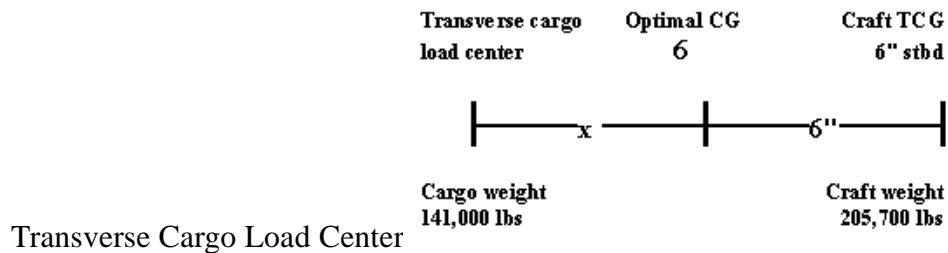
Table 4-24 Sample Load Problem LCG

Calculations		
205700 x 14	=	(X)141,000
2879800	=	141,000X
20.42	=	X
or		
20	=	X

Longitudinal cargo load center is $487 - 20 = 467$

Converted to feet, 467 inches - 38.91 feet or 39 feet

Mark cargo deck worksheet at 39 feet aft of FP



Refer to Table 4-25.

Table 4-25 Sample Load Problem LCG

<u>Calculations</u>		
205700 x 6	=	(X)141,000
1234200	=	141,000X
8.75	=	X
or		
9	=	X

Transverse cargo load center is 9 inches port of CenterLine

- d. Using the grid on the cargo deck worksheet, locate and label the longitudinal cargo load center at 39 feet aft of FP. Locate and label the transverse cargo load center at 9 inches port of centerline as shown in Single Item Cargo Plan View (Figure 4-16).

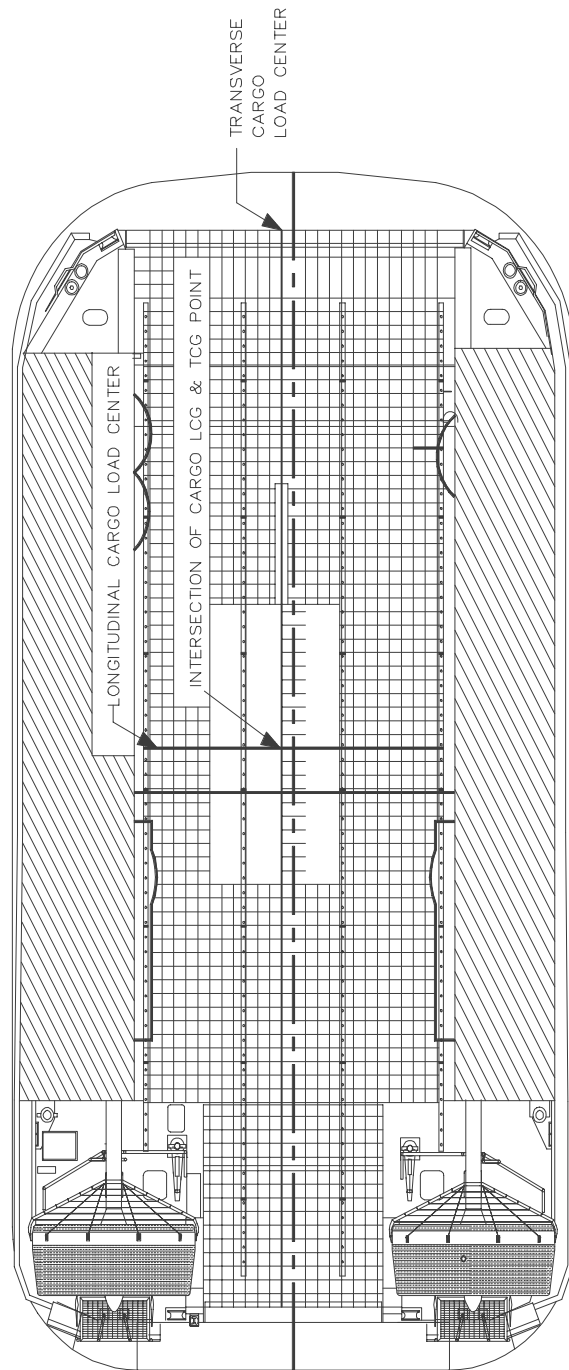


Figure 4-16 Single Item Cargo Plan View

- e. STEP 4. Spot cargo on the cargo deck worksheet. In this case, spot cargo as discussed for single item cargo loads; i.e., spot cargo CG over LCG and TCG intersection point on the cargo deck. Enter all data on the LCAC cargo load plan form.
- f. STEP 5. Enter all cargo on LCAC cargo load plan (Figure 4-17). Note: There is no entry for debits and credits.

* Fill in only if cargo is other than C .

- g. STEP 6. Use completed cargo deck worksheet to spot vehicle on the craft. Once the craft is loaded, add the cargo deck worksheet to craft file of cargo loads.

4-3. **LOADING**

The next step is properly loading the cargo on the LCAC. Loading any cargo whether it be a single vehicle or a mixed load of vehicles/cargo requires adherence to the load plan and all safety precautions.

4-3.1. **General Cargo Preparation And Loading** General cargo refers to all cargo except vehicles that can be loaded on the LCAC. It may vary from one large item to many smaller items. Small items should be loaded on pallets. The following procedures should be followed to expedite loading of general cargo:

- a. Assemble cargo to be loaded.
- b. Secure any loose ends or attaching parts of cargo.
- c. Be sure all wooden boxes are nailed tight and secured.
- d. Be sure boxes are to be loaded in accordance with instructions or arrows stamped on them.
- e. Secure cargo to pallets with metal straps or other restraints to ensure the cargo is adequately secured to the pallets.

4-3.2. **Dunnage** Dunnage is used for load distribution and protection of the cargo deck. The dunnage used for protecting the cargo deck from tracked vehicle cleats, bolt heads, banding materials, small steel wheels, castors and other cargo is usually light planks or plywood not more than 1 inch thick. Dunnage used for load distribution is usually heavy planking 2 inches thick and 10 inches to 12 inches wide.

The maximum allowable footprint loading for LCAC without dunnage is 80 psi. Any vehicle with a foot print pressure above 80 psi must have dunnage. Dunnage is normally required for tracked vehicles without rubber cleats and through loading operations. Use of thicker dunnage reduces the area required for distribution of the load. Use dunnage as required for load distribution and protection of the cargo deck.

4-3.3. **Forklift/Pallet Loading**



The loadmaster or a designated director shall direct the movement of all vehicles during cargo loading operations to prevent injury to personnel or damage to the craft.

Forklift loading of pallets on an LCAC is permitted as long as the footprint load of 80 psi is not exceeded. Also, movement and tiedown of the hard rubber-tired 6,000-pound forklift is limited to one-half capacity (3,000 pounds) anywhere on deck. The maximum weight for a single, standard pallet load is 3,000 pounds, except for NATO loads which are 2,500 pounds. The maximum weight of a palletized cluster can not exceed 6,000 pounds. This restriction is based on the LCAC cargo restraint criteria.

Palletized load operations assume that the pallets are loaded and banded in accordance with MIL-STD-147 for Palletized Unit Loads. These standards identify palletized military cargo load sizes, weights, and packaging requirements applicable to all branches of the military, including reserve units and NATO forces. The LCAC Loadmaster should reject any palletized cargo that is not properly banded and secured to the pallet. Even with the use of nets, improperly banded cargo is a Foreign Object Damage (FOD) hazard to the craft. Figure 4-18 depicts the maximum geometry of palletized military cargo on standard 40-inch by 48-inch pallets.

A larger pallet is used to transport War Reserve Material (WRM) and is designated as a 463L pallet. This pallet measures 108 inches by 88 inches and accepts a maximum cargo weight of 10,000 pounds. These pallets have their own cargo net system which is integral to the pallet and is designed to withstand 3G crash conditions. These pallets are typically shipped by the Military Sealift Command (MSC) or by the supply ships. This pallet, also, may be carried by the LCAC. Pallets should not be positioned any closer than 6 inches apart due to the spillover of cargo on the pallets, and the need to leave clearance for removal of lifting sling's bars. This allows for some shifting of the load while the craft is underway. Figure 4-19 shows MIL-S-18313 nylon cargo netting and pallet arrangement for four and eight pallet clusters secured to the LCAC cargo deck. The advantage of the eight-pallet cluster is that it minimizes the number of tiedowns required per pallet. Figure 4-20 shows an arrangement that allows the LCAC to carry 32 pallets and still provide adequate room to the craft machinery spaces for firefighting and maintenance. It is noted that palletized forklift access holes under pallets shall be positioned as to be accessible to a forklift from either the bow or stern ramp.

This arrangement groups the pallets into four clusters, with each cluster consisting of a 2 by 4 pallet matrix. Two cargo nets are lashed together to form a 12-foot by 24-foot net and placed over each pallet cluster as shown in Figure 4-19 . The tiedowns are secured to the net in the same manner as for a group of four pallets. The maximum weight of each eight-pallet cluster cannot exceed 6,000 pounds. This configuration allows the transport of eight lightweight pallets with the same number of tiedowns required to transport four heavy pallets. If the cargo is susceptible to water damage or needs to be protected from the LCAC cargo deck environment, a standard plastic cover (MIL-S-83991) is available that will cover a group of four pallets.

The individual pallets should be arranged in a group of four and covered with nylon cargo net (MIL-S-18313) as shown in Figure 4-21. The nets have a large D-ring on each corner for attaching tiedowns. Figure 4-19 shows an overhead diagram of the tiedown arrangement on the craft. When transporting a small number of pallets (12 or less) or heavy pallets, it is recommended that the pallets be secured in groups of four. When an eight-pallet cluster is used, two MIL-S-18313 nylon nets must be linked together. This is accomplished by using shackles to join the nets in the center of the group. These tiedowns are used to keep the netting secured around the load, and not to provide any restraint.

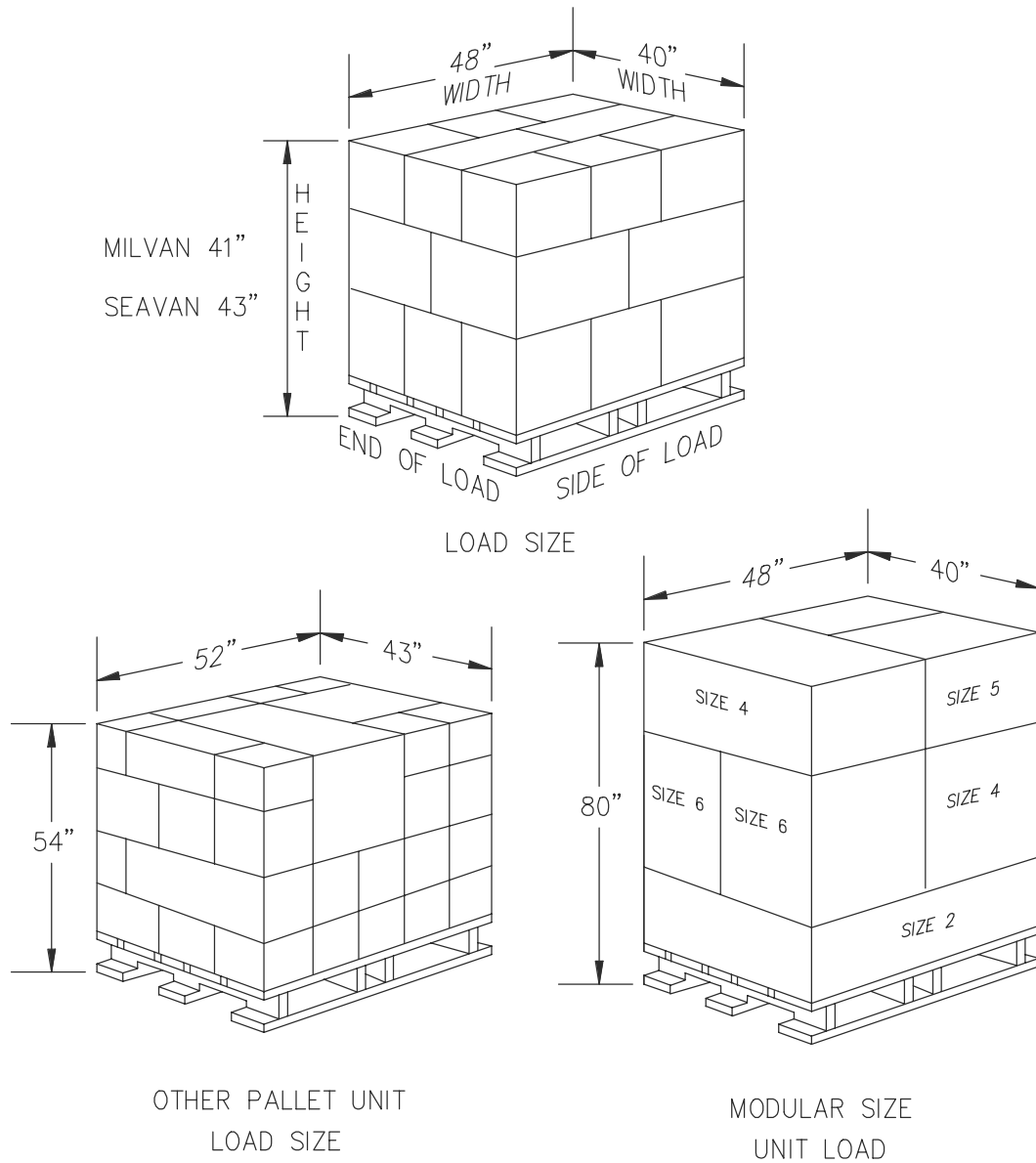


Figure 4-18 Pallet Geometry

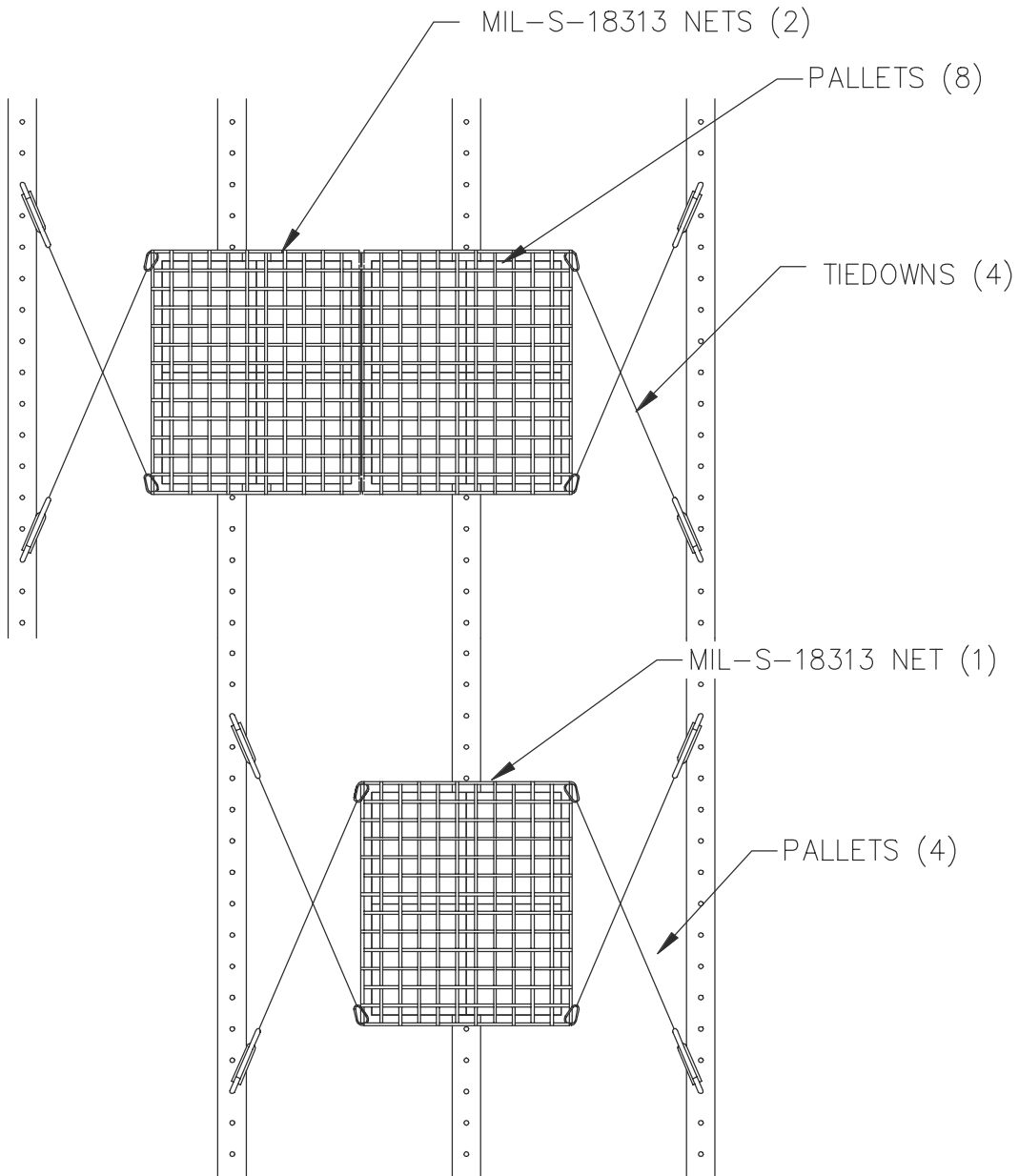


Figure 4-19 Pallet and Net Group Arrangements

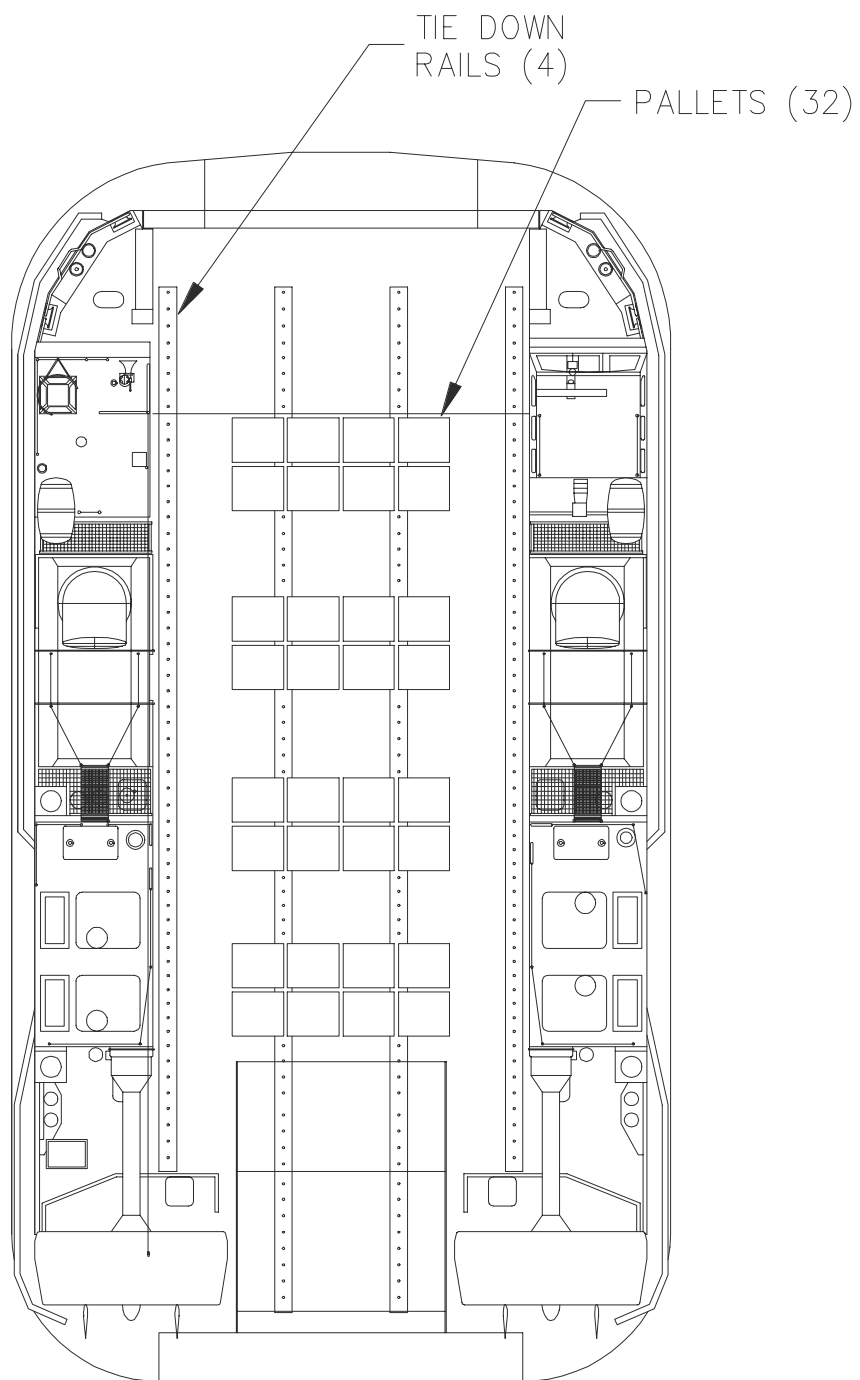


Figure 4-20 Cargo Deck and 32 Pallets

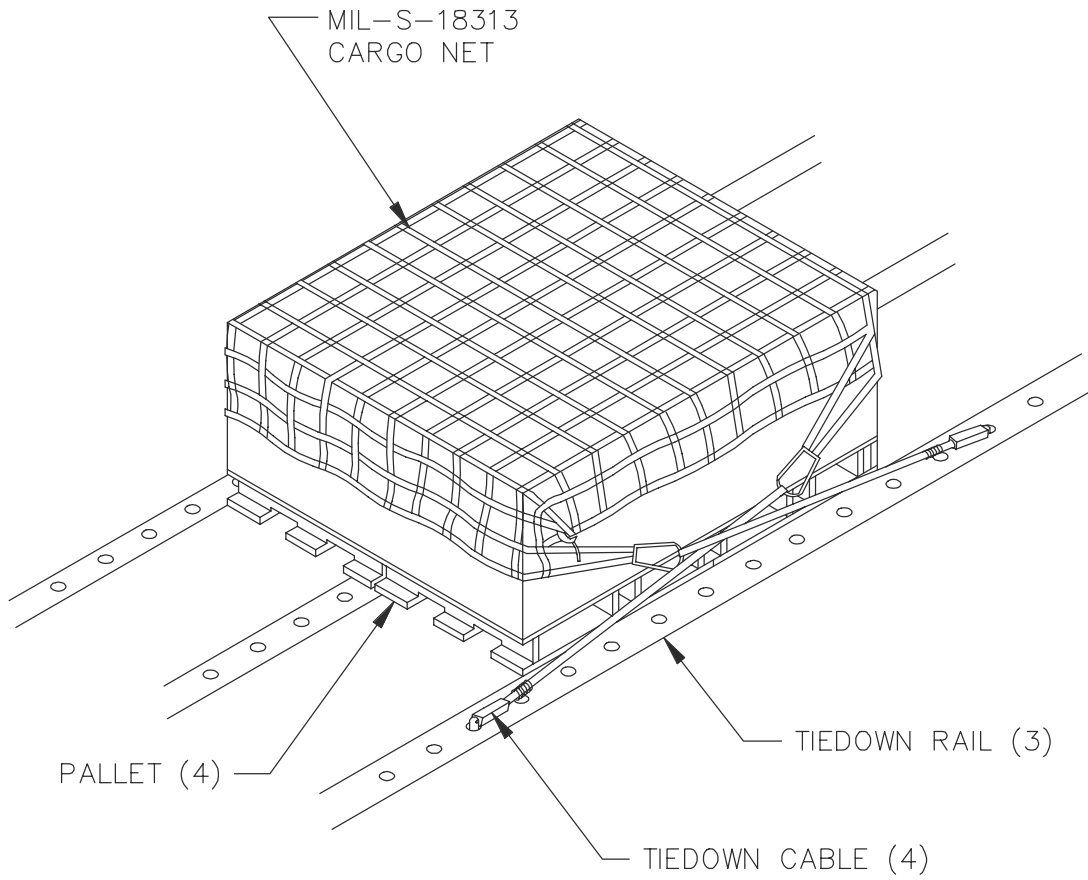


Figure 4-21 Pallet Block with MIL-S-18313 Net

Figure 4-22 shows a typical 463L pallet and net arrangement used for shipping WRM. The maximum weight for a 463L pallet is 10,000 pounds. When securing a 463L pallet to the deck, it is important that the tiedowns be attached to the highest level of rings on the side nets; do not attach tiedowns to net webbing.

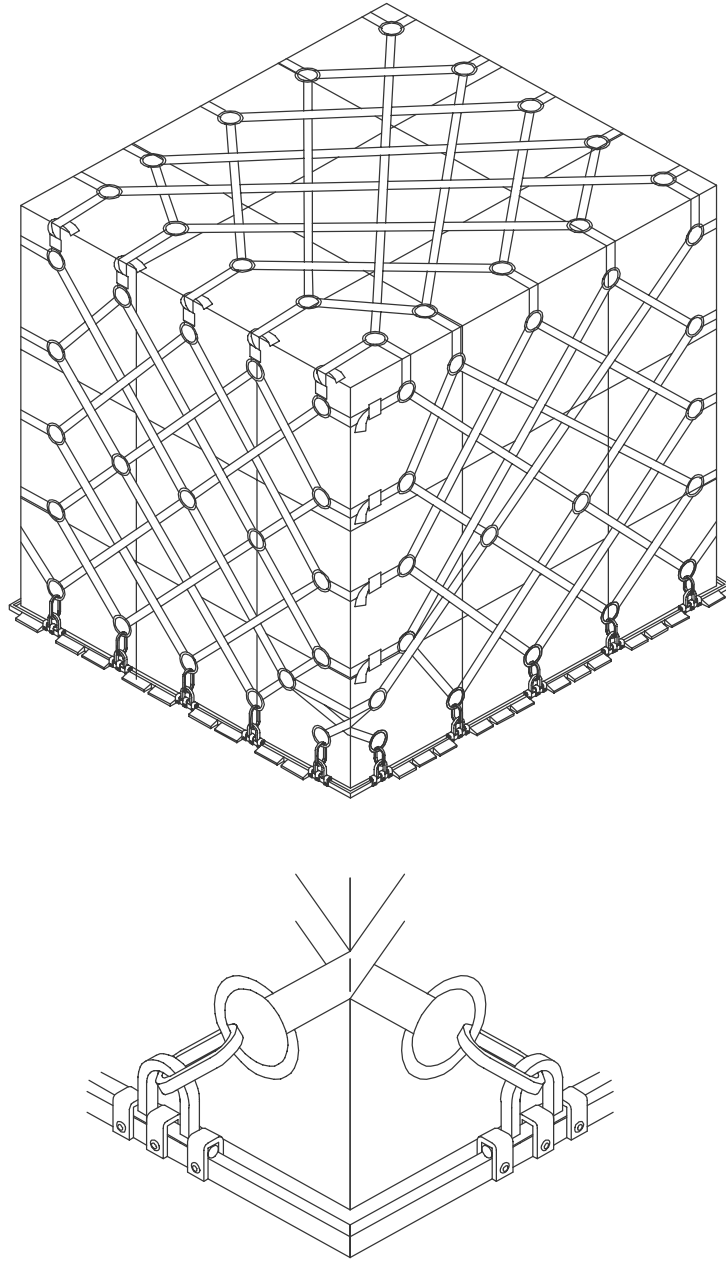


Figure 4-22 Typical 463L Pallet and Net

Pallets may be stowed aboard LCAC as long as the weight limitations and maximum allowable footprint loads are not exceeded. Palletized loads shall be spotted to provide a balanced craft.

Whenever loading an LCAC by wheeled vehicle, one individual should direct the vehicle operator by using the hand signals in Figure 4-23. Night signals are the same as daylight signals using an illuminated wand or a flashlight. All vehicle drivers and directors must be familiar with the correct hand signals.

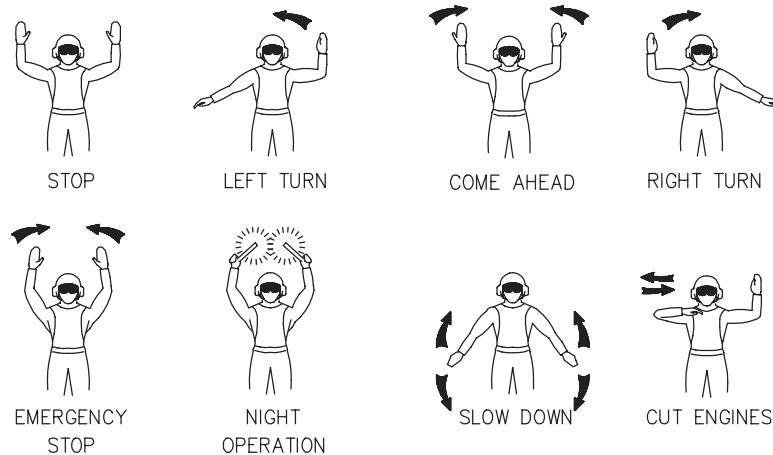


Figure 4-23 Wheeled Vehicle Maneuvering Hand Signals

4-3.4. Wheeled/Tracked Vehicle Loading The loading of wheeled and tracked vehicles can be accomplished through either stern or bow ramps after all preload planning including load placement has been completed. The vehicles should be loaded in accordance with the load plan and not exceeding the deck limitations shown in Figure 2-3 . The following should be accomplished before loading vehicles on an LCAC.

- Assemble all vehicles for loading.
- Secure all loose cargo in the vehicles.
- Tighten all gas tank caps, battery caps and oil filler caps.
- Check the brakes of all vehicles before driving them onto the LCAC.

Once preloading activities are completed and the LCAC is in position, the following procedures should be followed when loading wheeled/ tracked vehicles.



Prior to ramp operations ensure the area under the ramp is clear of foreign objects and personnel to prevent damage to the craft or injury to personnel.

- a. Lower the ramp(s).
- b. Clear cargo deck as necessary and ready deck for loading.
- c. Deploy dunnage as required.
- d. Load vehicles (one at a time). Tracked vehicle maneuvering hand signals as shown in Figure 4-24.
- e. After vehicle is positioned, check:
 - Vehicle ignition off.
 - Parking brake set.
 - Windows rolled up.
 - Passengers disembarked (except for select vehicles).
 - Check vehicle for FOD.
- f. Restrain cargo (vehicle operators help restrain vehicles).
- g. Inspect vehicles for proper loading/restraint/FOD.
- h. Vehicle operators/passengers proceed to assigned troop station.
- i. Raise ramp.

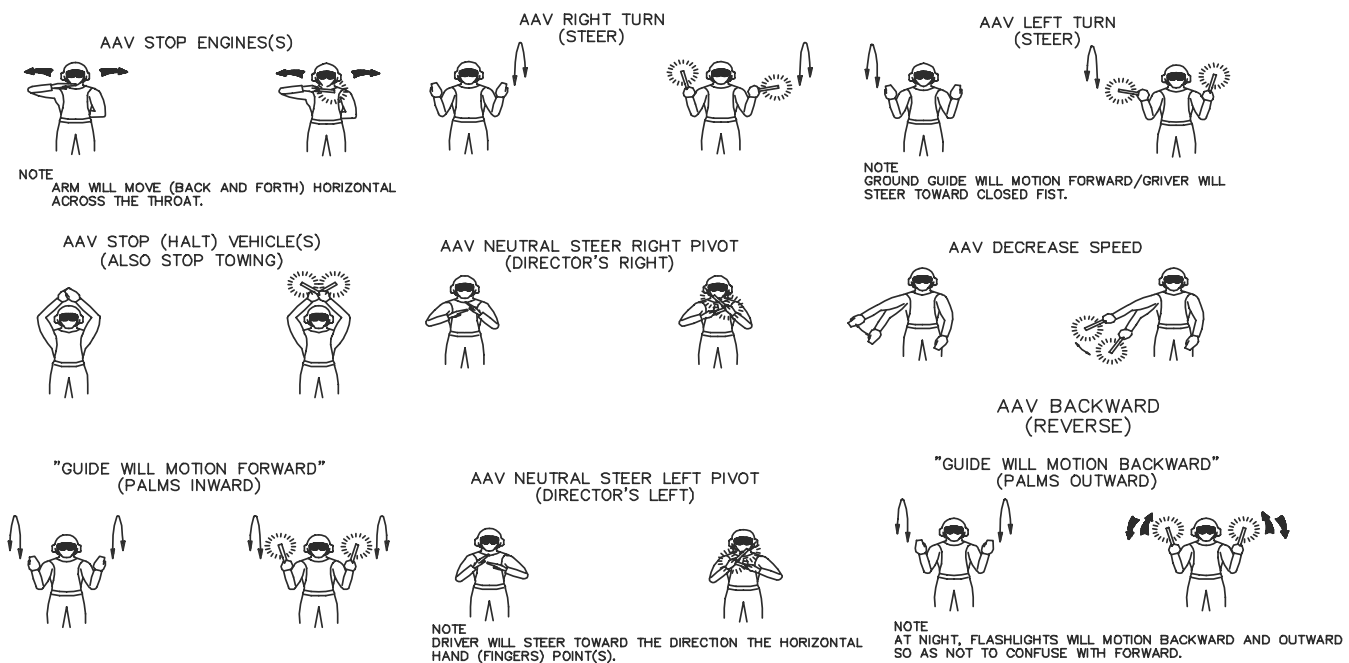


Figure 4-24 Tracked Vehicle Maneuvering Hand Signals

4-3.5. Crane Loading The LCAC can be loaded by ships, boat and aircraft (B & A) cranes, cargo monorail system, and bridge cranes within the well decks of amphibious ships and B & A cranes when moored along side. See SEAOPS Volume III for specific capability on amphibious ships. LCAC can also be loaded by crane when along side a pier or on a beach when forklifts are not available or feasible.

Cargo loading an LCAC by crane does not change any of the restrictions on deck loads. The most frequent items loaded by crane are pallets, small vehicles and other small cargo. Since loading by crane involves overhead operations, it is imperative that all safety precautions are adhered to.

When loading LCAC by crane use the following procedures.

- a. Brief all personnel involved in the loading operation on load plan and safety precautions.
- b. Ensure proper safety equipment is being worn by all personnel.
- c. Ensure cargo slings/handling equipment is in calibration and in proper working order.
- d. Ensure that loadmaster is in a safe, easily seen position to properly direct loading.

NOTE

If loads are to be lowered directly on to the LCAC, the loadmaster will direct loading.

Use crane maneuvering hand signals shown in Figure 4-25.

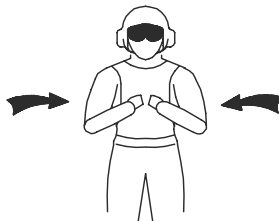




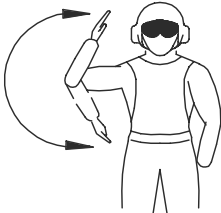
<p>HAND SIGNALS FOR DIRECTING CRANE OPERATIONS</p> <p>THE UNIFORM SYSTEM OF SIGNALS RECOMMENDED FOR USE IN DIRECTING BOOM OPERATIONS IS SHOWN ON THE FOLLOWING PAGES.</p> <p>THE SIGNALS IN USE SHOULD BE POSTED AT THE OPERATOR'S POSITION, AT THE CONTROL POINTS, AND AT SUCH OTHER POINTS AS NESSECARY TO PROPERLY INFORM THOSE CONCERNED. THE SIGNALMAN MUST BE LOCATED SO AS TO BE CLEARLY VISIBLE TO THE OPERATOR AT ALL TIMES. A SIGNALMAN SHOULD BE PROVIDED WHENEVER THE POINTNT OF OPERATION IS NOT IN FULL AND DIRECT VIEW OF MACHINE OR EQUIPMENT OPERATOR. A WARNING DEVICE OR SIGNALMAN SHOULD BE PROVIDED WHEREVER THERE IS DANGER TO PERSONS FROM MOVING EQUIPMENT.</p>		 <p>LOCK / UNLOCK SPREADER BAR BAYONETS: CLOSE FISTS AND TAP TOGETHER IN FRONT OF CHEST.</p>
 <p>TAG LINES IN: HOLD BOTH FISTS IN FRONT WITH THUMBS EXTENDED IN.</p>	 <p>TAG LINES OUT: HOLD BOTH FISTS IN FRONT WITH THUMBS EXTENDED OUT.</p>	 <p>ROTATE ROTATOR BLOCK: HAND RAISED WITH FINGERS UP IN GRASPING POSITION. ROTATE HAND IN DIRECTION DESIRED.</p>
 <p>SHIFT SPREADER BAR WEIGHT: EXTEND ARMS AND THEN TILT THEM IN DIRECTION OF WEIGHT SHIFT.</p>		 <p>RAISE / LOWER SPREADER BAR GUIDE ARMS: EXTEND ARM AND THEN RAISE OR LOWER.</p>

Figure 4-25 Crane Maneuvering, Hand Signals (Sheet 1 of 2)



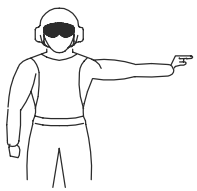

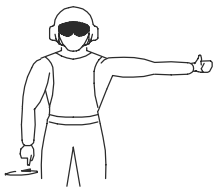
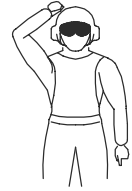
 <p>RAISE THE HOOK / LOAD FOREFINGER EXTENDED, POINTED UP AND CIRCLING, FOR FASTER SPEED USE TWO OR MORE FINGERS.</p>	 <p>LOWER THE HOOK / LOAD SAME AS RAISE THE HOOK, EXCEPT FOREFINGER POINTS DOWN.</p>	 <p>SLEW / ROTATE CRANE: HAND POINTED IN DIRECTION OF MOVEMENT.</p>
 <p>RAISE THE BOOM/LUFF UP FIST CLOSED, THUMB EXTENDED AND POINTING UP.</p>	 <p>LOWER THE BOOM/LUFF DOWN SAME AS RAISE THE BOOM, EXCEPT THUMB POINTING DOWN.</p>	 <p>STOP BOOM—STOP HOIST HANDS RAISED, FISTS CLOSED.</p>
 <p>RAISE THE HOOK, LOWER THE BOOM RIGHT HAND SIGNALS TO RAISE THE LOAD, LEFT HAND SIGNALS TO LOWER BOOM.</p>	 <p>LOWER THE HOOK, RAISE THE BOOM RIGHT HAND SIGNALS TO LOWER THE HOOK, LEFT HAND SIGNALS TO RAISE THE BOOM.</p>	 <p>USE RIDER BLOCK—BRING UP OR DOWN RIGHT HAND TAPS HELMET WITH FIST, LEFT HAND POINTS UP OR DOWN.</p>

Figure 4-25 Crane Maneuvering, Hand Signals (Sheet 2 of 2)



Prior to ramp operations ensure the area under the ramp is clear of foreign objects and personnel to prevent damage to the craft or injury to personnel.

- e. Lower ramp.
- f. Load cargo according to load plan.
- g. Restrain cargo.
- h. Inspect cargo load for FOD.
- i. Raise ramp.

4-3.6. Vehicle Loading Pocket Handbook A vehicle loading pocket handbook has been compiled to be a quick reference guide for loading the most frequently transported vehicles and has 10 serial loads of commonly transported equipment. The handbook is divided into 3 sections, Section I - USMC Equipment Characteristics and Tiedown Arrangements, Section II - Cargo Tiedown Calculation Procedures, and Section III - Serial Loads of Multi-Vehicle Types. This handbook provides all the information required to properly spot and secure the individual USMC vehicles listed. The vehicles are listed by USMC Table of Authorized Material Control Numbers (TAMCN). The handbook provides an illustration of each vehicle and all necessary vehicle characteristics required to do load planning (Figure 4-26). The handbook also provides illustrations of the required tiedowns for both peacetime and combat loads. Tiedown calculations procedures are provided for in Section II. Ten serial loads of multi-vehicle types are provided for in Section III. These loads which are shown in a plan view, must be balanced with the mission craft.

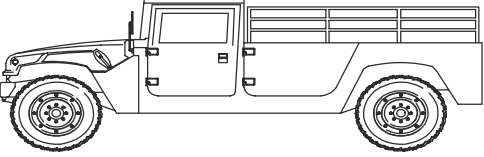
<p>NOMENCLATURE: Truck, Util, Cargo/Trp Carrier, 1-1/4 Ton, HMMWV, M998</p> 	<p>D1158</p> <p>Width: 84"/7'</p> <p>Length: 187"/15' 7"</p> <p>Height: 74"/6' 2"</p> <p>Empty Weight: 5300 lb</p> <p>Weight Full Capacity: 7800 lb</p> <p>Frnt. Axle to Veh. Rear: 157"/13' 1"</p> <p>Ground Clearance: 10"</p> <p>Footprint Pressure: 22 PSI</p> <p>CG Loaded: 84"/7' from front axle 9' 6" from front of vehicle 6' 1" from rear of axle</p> <p>CG Empty: 69"/5' 9" from front axle 8' 3" from front of vehicle 7' 4" from rear of vehicle</p>
<p>REMARKS:</p>	

Figure 4-26 Example of Vehicle Characteristics from the Vehicle Loading Pocket Handbook

4-3.7. Troop Loading When troops are embarked in armored vehicles, the weight of the troops is included in the weight of the vehicle. In armored vehicles (AAV, LAV, MBT, Hardback HMMWVs), the vehicle crew and assigned troops may remain in the vehicle while the LCAC is underway. These personnel must wear single hearing protection. For all other vehicles, crews and embarked troops shall be carried in the LCAC passenger compartments.

The LCAC has the capability of carrying up to 23 troops without PTM installed. Seven spaces are allocated in the starboard cabin and 16 in the port cabin. With PTM installed, a maximum of 180 additional troops can be carried aboard LCAC. SEAOPS Manual for Alternate Missions, S9LCA-AA-SSM-080, Volume VI, Chapter 1 contains a system description and operating procedures for PTM. The weight of these troops must be considered as a portion of the overall cargo weight and included in the load planning process. For planning purposes, the following weights are average:

- 250 pounds for one combat loaded Marine with weapon, flak jacket, pack, and basic allowance of ammunition.
- 200 pounds for one Marine without combat equipment.

Total troop weight will vary, depending upon the number to be embarked, and consequently should be considered for each serial load. The number seated in each cabin should be equalized if possible to minimize the effect on athwartship balance. For fore and aft balance, troop weight must be added to and computed in the same manner as is done for vehicles and general cargo.

Prior to embarking troops in the passenger compartments ensure the following steps are complete.

- a. Troop seats and seatbelts installed and operational.
- b. Passenger compartment deck cleared of unnecessary articles.
- c. Emergency equipment installed and checked.

4-3.8. Litter Loading There are no provisions in the passenger compartments for litter transport of injured personnel. In an emergency, this does not preclude the use of the passenger compartments from being used to carry injured personnel when no other means are available to get personnel medical attention as soon as possible. With PTM installed, litters can be carried aboard LCAC. SEAOPS Manual for Alternate Missions, S9LCA-AA-SSM-080, Volume VI, Chapter 1 contains a system description and operating procedures for PTM.

4-3.9. Post Loading After cargo has been loaded, tiedown devices must be applied to secure the load in the proper location and to provide the required amount of restraint.

4-4. CARGO RESTRAINT

LCAC operations are not permitted unless onboard cargo is properly restrained. When the cargo is properly secured to the LCAC cargo deck, the possibility of damage occurring to the load or the craft by cargo shifting is greatly reduced. Cargo restraint is the responsibility of the loadmaster.

4-4.1. Restraint Criteria The amount of restraint that must be used to keep cargo from moving, in any direction is "restraint criteria". It is expressed in units of the force of gravity, or Gs, the cargo must

overcome. The Gs required to be restrained in four directions for both peacetime/training and combat loads are shown in Table 4-26.

Table 4-26 LCAC Restraint Criteria

Direction	Peacetime/ Training	Combat
Forward	$1\frac{1}{2}$ Gs	1G
Aft	1Gs	$\frac{1}{2}$ G
Side	1Gs	$\frac{1}{2}$ G
Vertical	$1\frac{1}{2}$ Gs	$\frac{1}{2}$ G

This means the force exerted by an object or cargo to be restrained is the normal weight times the Gs of the restraint criteria. For example, an object weighing 2,000 pounds must have a forward restraint of 3,000 pounds (1,000 pounds x $1\frac{1}{2}$ Gs = 3,000 pounds) for peacetime/ training operations. For other directions, the same 2,000-pound object must have a restraint criteria to restrain a force of 2,000 pounds aft, 2,000 pounds to either side, and 3,000 pounds upward. For the object to be safely carried, the restraint provided must be equal to, or greater than, these amounts.

Cargo restraint criteria for the vehicles listed in the vehicle loading handbook have already been calculated and should be utilized by the loadmaster for restraining these vehicles. For all other cargo the loadmaster/load planner must calculate the restraint required.

Restraint is given the name of the direction in which it is meant to keep the cargo from moving. "Forward restraint" keeps it from moving forward. "Aft restraint" keeps it from moving aft. "Side restraint" keeps it from moving to one side or the other. "Vertical restraint" keeps it from moving upward only, the downward restraint is supplied by the cargo deck.

The minimum cargo restraint criterion used for LCAC tiedown positions are categorized into two arrangements, peacetime/training and hostile fire (see Table 4-26).

Both tiedown arrangements provide for the safe transport of equipment aboard LCAC but the peacetime/training plan provides a lower risk and should be used at all times unless damage to the craft, personnel, and/or equipment can be anticipated from hostile fire during the unload evolution ashore. The hostile fire arrangement will significantly reduce tiedown removal for large items of equipment, which have previously had more tiedowns. A listing of USMC equipment, Table of Authorized Material Control Number (TAMCN) is provided in Table 4-6.

The weights listed in Table 4-6 are based upon USMC embarkation weights. Restraint criterion are based upon expected operational loading of the LCAC operating in a SWH of 3.5 to 5 feet. However, when the LCAC is secured within a well deck ship, cargo on the LCAC deck may be subjected up to a SWH of 29.5 to 45.5 feet. Forward, aft, and athwartship tiedown requirements will vary from ship to ship, depending on operational characteristics, and are provided in SEAOPS Volume III, Well Deck Operations.

4-4.2. Cargo Load Restraint The tiedown devices shown in Figure 2-7 are connected between the cargo load and the tiedown receptacles in the cargo deck, to provide the means for restraining the cargo load. Tiedown receptacles have a maximum load capability of 40,250 pounds. receptacle horizontal and longitudinal pull angles range from 15 to 80 degrees from horizontal. Working load is 35,000 pounds at the optimum 30 degree restraint angle.

4-4.3. General Rules For Application Of Tiedown Devices The greatest amount of restraint is required in the forward and aft directions; therefore the vertical angle should be as small as possible, but large enough to provide the required vertical restraint. Side restraint criteria are much less than forward and aft restraint criteria. Vertical restraint should normally be no problem as of all of the tiedown devices used for forward and aft, and side restraint are providing some vertical restraint as long as they are connected to the cargo load at some vertical angle.

The following general rules should be used, whether or not the cargo is equipped with tiedown fittings:

- a. Determine number of tiedown devices required to provide required restraint in all directions.
- b. Always apply an even number of tiedown devices attached in pairs for forward and aft restraint and on opposite sides for side restraint.
- c. Check restraint by reference to restraint computation values.
- d. After applying all required tiedown devices, especially on cargo not equipped with tiedown devices, check to ensure load will not slip. Additional tiedowns may be necessary to prevent load slippage.

4-4.4. Cargo Tiedown Calculation Procedures This section provides cargo tiedown restraint calculation procedures for each tiedown, using both angle measurements and distance measurement methods.

4-4.4.1. Cargo Tiedown Calculation Procedures Using Angle Measurements An illustration of the angles involved for a single tiedown is provided in Figure 4-27. Figures 4-28 and 4-29 are examples of the forms used to calculate and record cargo restraints. Except for a straight pull parallel to the decks and at a right angle to the cargo, each tiedown will provide restraint in three directions: forward or aft, athwartship and vertically. The amount varies with the angles of the tiedown. The percentage difference from a straight pull is provided in Table 4-27.

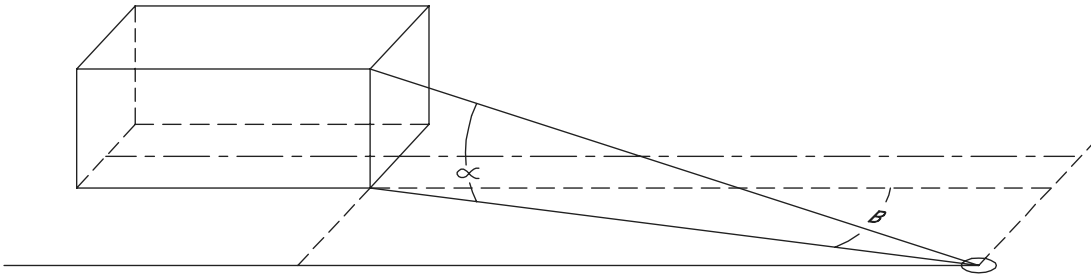


Figure 4-27 Angle Measurements to Determine Cargo Restraint

1. VEHICLE DESCRIPTION/TAMCN #: _____	DATE: _____
2. CARGO WEIGHT _____ lb	
3. REQUIRED RESTRAINT FORCES <small>(ROUNDED TO THE NEAREST 100 LBS)</small>	
a. PEACETIME/TRAINING MISSION	
Forward restraint	= 1.5 x cargo weight = _____ lb
Vertical restraint	= 1.5 x cargo weight = _____ lb
Port restraint	= 1 x cargo weight = _____ lb
Starboard restraint	= 1 x cargo weight = _____ lb
Aft restraint	= 1 x cargo weight = _____ lb
b. HOSTILE FIRE MISSION	
Forward restraint	= 1 x cargo weight = _____ lb
Vertical restraint	= 0.5 x cargo weight = _____ lb
Port restraint	= 0.5 x cargo weight = _____ lb
Starboard restraint	= 0.5 x cargo weight = _____ lb
Aft restraint	= 0.5 x cargo weight = _____ lb
4. INITIAL TIEDOWN REQUIREMENTS	
Forward restraint weight ÷ 35,000	= _____
Vertical restraint weight ÷ 35,000	= _____
Port restraint weight ÷ 35,000	= _____
Starboard restraint weight ÷ 35,000	= _____
Aft restraint weight ÷ 35,000	= _____
	A. PEACETIME/TRAINING B. HOSTILE FIRE

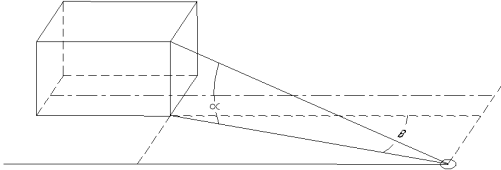
5. TIEDOWN DIMENSIONS	
	CABLE 1 CABLE 2 CABLE 3 CABLE 4 CABLE 5
Angle α in deg	_____ deg _____ deg _____ deg _____ deg _____ deg
Angle $\hat{\alpha}$ in deg	_____ deg _____ deg _____ deg _____ deg _____ deg
6. PERCENT RESTRAINT <small>(REFER TO TABLE 4-4)</small>	
	CABLE 1 CABLE 2 CABLE 3 CABLE 4 CABLE 5
Longitudinal (Forward/Aft) in %	_____ % _____ % _____ % _____ % _____ %
Vertical in %	_____ % _____ % _____ % _____ % _____ %
Lateral (Port/Starboard) in %	_____ % _____ % _____ % _____ % _____ %
7. RESTRAINT CABLE NUMBERS 1-5	
a. Restraint from cable in longitudinal (forward or aft) direction =	1 2 3 4 5
$\frac{(2) \times (35,000 \text{ lb}) \times (\text{longitudinal (forward or aft) \%})}{100} =$	_____ lb _____ lb _____ lb _____ lb _____ lb
b. Restraint from cable in vertical direction =	
$\frac{(2) \times (35,000 \text{ lb}) \times (\text{vertical \%})}{100} =$	_____ lb _____ lb _____ lb _____ lb _____ lb
c. Restraint from cable in lateral (port or starboard) direction =	
$\frac{(1) \times (35,000 \text{ lb}) \times (\text{lateral \%})}{100} =$	_____ lb _____ lb _____ lb _____ lb _____ lb
	
Angle Measurements to Determine Cargo Restraint	
<small>* When cable pairs are not symmetrical, calculate restraint for each individual cable.</small>	

Figure 4-28 LCAC Restraint Calculation Worksheet Using Angle Measurements

VEHICLE DESC.: _____					
LCAC/MISSION: _____				DATE: _____	
CABLE NUMBER (PAIRS)	FORWARD RESTRAINT	AFT RESTRAINT	VERTICAL RESTRAINT	LATERAL RESTRAINT	
				PORT	STARBOARD
<i>Totals</i>					
<i>REQUIREMENT</i>					
HOSTILE FIRE					
<i>Totals</i>					
<i>REQUIREMENT</i>					

Figure 4-29 Cargo Restraint Summary

Table 4-27 Percentage Restraint Summary

	α^1	5°	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	65°	70°	75°	80°	85°
β^2	VERT ³	8.7	17.4	25.9	34.2	42.3	50.0	57.4	64.3	70.7	76.6	81.9	86.6	90.6	93.9	96.6	98.5	99.6
5°	LONG	99.2	98.1	96.2	93.6	90.2	86.3	81.6	76.3	70.4	64.0	57.2	49.8	42.1	34.1	25.8	17.3	8.7
	LAT	8.7	8.6	8.4	8.2	7.9	7.5	7.1	6.7	6.2	5.6	4.9	4.4	3.7	2.9	2.3	1.5	0.8
10°	LONG	98.1	97.0	95.2	92.6	89.2	85.3	80.7	75.5	69.6	63.3	56.5	49.3	41.7	33.7	25.5	17.1	8.6
	LAT	17.3	17.1	16.8	16.6	15.8	15.1	14.3	13.3	12.3	11.2	9.9	8.7	7.4	5.9	4.5	3.0	1.5
15°	LONG	96.2	95.2	93.3	90.8	87.5	83.7	79.1	73.9	68.3	62.1	55.4	48.3	40.9	33.0	25.0	16.8	8.4
	LAT	25.8	25.5	25.0	24.3	23.5	22.4	21.2	19.8	18.3	16.7	14.9	12.9	10.9	8.9	6.7	4.5	2.3
20°	LONG	93.6	92.6	90.8	88.4	85.2	81.4	76.9	72.0	66.5	60.4	53.9	47.0	39.8	32.1	24.3	16.6	8.2
	LAT	34.1	33.7	33.0	32.1	30.9	29.6	28.0	26.2	24.2	21.9	19.6	17.1	14.5	11.7	8.9	5.9	2.9
25°	LONG	90.2	89.2	87.5	85.2	82.1	78.5	74.2	69.4	64.1	58.3	52.0	45.3	38.3	30.9	23.5	15.4	7.9
	LAT	42.1	41.7	40.9	39.8	38.3	36.6	34.6	32.4	29.9	27.2	24.3	21.2	17.9	14.5	10.9	7.4	3.7
30°	LONG	86.3	85.3	83.7	81.4	78.5	74.9	70.9	66.3	61.2	55.7	49.7	43.3	36.6	29.6	22.4	15.1	7.5
	LAT	49.8	49.3	48.3	47.0	45.3	43.3	40.9	38.3	35.4	32.2	28.7	25.0	21.2	17.1	12.9	8.7	4.4
35°	LONG	81.6	80.7	79.1	76.9	74.2	70.9	67.1	62.7	57.9	52.7	47.0	40.9	34.6	28.0	21.2	14.3	7.1
	LAT	57.2	56.5	55.4	53.9	52.0	49.7	47.0	43.9	40.6	36.9	32.9	28.7	24.3	19.6	14.9	9.9	4.9
40°	LONG	76.3	75.5	73.9	72.0	69.4	66.3	62.7	58.7	54.2	49.3	43.9	38.3	32.4	26.2	19.8	13.3	6.7
	LAT	64.0	63.3	62.1	60.4	58.3	55.7	52.7	49.3	45.5	41.3	36.9	32.2	27.2	21.9	16.7	11.2	5.6
45°	LONG	70.4	69.6	68.3	66.5	64.1	61.2	57.9	54.2	49.9	45.5	40.6	35.4	29.9	24.2	18.3	12.3	6.2
	LAT	70.4	69.6	68.3	66.5	64.1	61.2	57.9	54.2	49.9	45.5	40.6	35.4	29.9	24.2	18.3	12.3	6.2
50°	LONG	64.0	63.3	62.1	60.4	58.3	55.7	52.7	49.3	45.5	41.3	36.9	32.2	27.2	21.9	16.7	11.2	5.6
	LAT	76.3	75.5	73.9	72.0	69.4	66.3	62.7	58.7	54.2	49.3	43.9	36.8	32.4	26.2	19.8	13.3	6.7
55°	LONG	57.2	56.5	55.4	52.9	52.0	49.7	47.0	43.9	40.6	36.9	32.9	28.7	24.3	19.6	14.9	9.9	4.9
	LAT	81.6	80.7	79.1	76.9	74.2	70.9	67.1	62.7	57.9	52.7	47.0	40.9	34.6	28.0	21.2	14.3	7.1

Table 4-27 Percentage Restraint Summary (Cont.)

α^1	5°	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	65°	70°	75°	80°	85°
60°	LONG	49.8	49.3	48.3	47.0	45.3	43.3	40.9	38.3	35.4	32.2	28.7	25.0	21.2	17.1	12.4	8.7
	LAT	86.3	85.3	83.7	81.4	78.5	74.9	70.9	66.3	61.2	55.7	49.7	43.3	36.6	29.6	22.4	15.1
65°	LONG	42.1	41.7	40.9	39.8	38.3	36.6	34.6	32.4	29.9	27.2	24.3	21.2	17.9	14.5	10.9	7.4
	LAT	90.2	89.2	87.5	85.2	82.1	78.5	74.2	69.4	64.1	58.3	52.0	45.3	38.3	30.9	23.5	15.8
70°	LONG	24.1	33.7	33.0	32.1	30.9	29.6	28.0	26.2	24.2	21.9	19.6	17.1	14.5	11.7	8.9	5.9
	LAT	93.6	92.6	90.8	88.4	85.2	81.4	76.9	72.0	66.5	60.4	53.9	47.0	39.8	32.1	24.3	16.6
75°	LONG	25.8	25.5	25.0	24.3	23.5	22.4	21.2	19.8	18.3	16.7	14.9	12.9	10.9	8.9	6.7	4.5
	LAT	96.2	95.2	93.3	90.8	87.5	83.7	79.1	73.9	68.3	62.1	55.4	48.3	40.9	33.0	25.0	16.8
80°	LONG	17.3	17.1	16.8	16.6	15.8	15.1	14.3	13.3	12.3	11.2	9.9	8.7	7.4	5.9	4.5	3.0
	LAT	98.1	97.0	95.2	92.6	9.2	85.3	80.7	75.5	69.6	63.3	56.5	49.3	41.7	33.7	25.5	17.1
85°	LONG	8.7	8.6	8.4	8.2	7.9	7.5	7.1	6.7	6.2	5.6	4.9	4.4	3.7	2.9	2.3	1.5
	LAT	99.2	98.1	96.2	93.6	90.2	86.3	81.6	76.3	70.4	64.0	57.2	49.8	42.1	34.1	25.8	17.3

NOTE

1. Angles across the top are those formed between the tiedown device and the deck (α).
2. Angles down the sides are those formed between the tiedown device and the longitudinal axis of the craft (β).
3. Vertical restraint is related only to the angle between the tiedown device and the deck. The lateral angles has no bearing on it.
4. The shaded area indicates the best compromise position.

- a. List vehicle description/TAMCN number on line 1 of Figure 4-28 .
- b. Determine cargo weight in pounds (lbs), and enter on line 2 of Figure 4-28 .
- c. Determine the required restraint in the forward, vertical, lateral (port and starboard), and aft directions by multiplying the cargo weight by the peacetime/training restraint criteria line 3a or the hostile fire restraint criteria line 3b as appropriate. Enter this data in the appropriate columns for peacetime/ training and/or hostile fire missions as required on the Cargo Restraint Summary, Figure 4-29.
- d. Make an initial determination of the number of tiedowns required for either or both missions as required. Divide the required restraint (values calculated in step 3) by 35,000 pounds and list on line 4 of Figure 4-28 . Always use an even number of tiedowns in each restraint direction (use tiedowns in pairs). When number of tiedowns is not a whole number, always round up to the next whole number (e.g., 4.1 is rounded up to 5). When an odd number of tiedowns is calculated, increase the number by 1. Tiedown the cargo with this number of tiedowns.

NOTE

Cable restraint is calculated in pairs except when cables are not symmetrical.

- e. Determine the restraint applied by an individual set of cables. (Note: All cables come in pairs). To complete this step the angle between the tiedown device and the deck (angle α) and the angle between the tiedown and the longitudinal (forward or aft) axis of the craft (angle β) must be determined. There are two ways to determine the angles (1) measurement or (2) mathematically. The measurement method would be accomplished by using a protractor to physically measure the angle on deck or of an appropriately scaled drawing. The mathematical method requires using the lengths of the sides of the triangle formed by angle in question and then solving for the angle trigonometrically. The mathematical method will be discussed in depth in the sample problem. Enter the angles on line 5 of Figure 4-28 .
- f. Determine the restraint percentages using the percentage restraint summary of Table 4-27 and enter on line 6 of Figure 4-28 . Number the cables to minimize confusion.
- g. Next, determine the cable restraint in each direction using the formulas in line 7a, b, or c of Figure 4-28 . The working strength of an individual cable is 35,000 pounds. Since the restraint of the cables is for a pair, multiply by two in the forward/aft and vertical directions. Multiply by one in the port/starboard direction because these cables counteract each other. Perform calculations, then enter the calculated restraint for each direction on line 6a, b, and c of Figure 4-28 and in the appropriate columns of Figure 4-29 .
- h. Total all numbers in all columns on the Cargo Restraint Summary, Figure 4-29 . As is indicated in Figure 4-29 , the sum of the restraint of all cables is used to meet the total restraint requirements. Compare the totals in Figure 4-29 to the required restraint forces for peacetime/training or hostile fire mission or both. If the totals are equal to or larger than the required restraint forces then the cargo is adequately restrained. If not, add tiedowns until the totals equal or exceed the required restraint forces.
- i. Repeat steps a., b., c., d., e., f., g. and h. until all equipment is properly restrained.

4-4.4.2. **Sample Problem** Using the angle measurement method, develop a restraining plan for the TRAM, vehicle TAMCN B2567/B0215.

- a. STEP 1. Position vehicle on the cargo deck. For illustrative purposes, an overhead view of the vehicle is placed on a blank cargo deck as used in the pocket handbook (Figure 4-30).

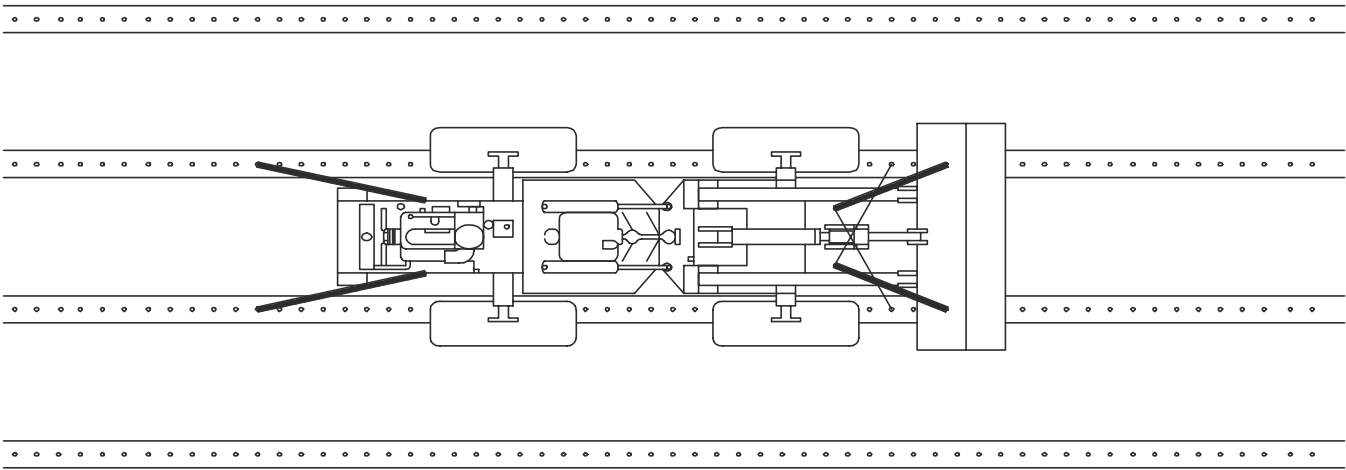
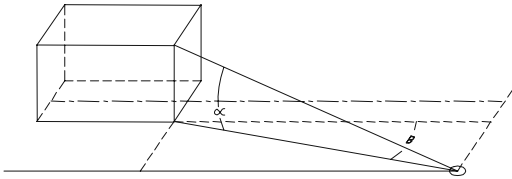


Figure 4-30 Tiedown Calculation for Sample Problems

- b. STEP 2. Enter TAMCN B2567/B0215 on line 1 of angle measurement sample worksheet (Figure 4-31).

1. VEHICLE DESCRIPTION/TAMCN #: <u>B2567/B0215</u>	DATE: <u>July 93</u>
2. CARGO WEIGHT <u>36300</u> lb	
3. REQUIRED RESTRAINT FORCES (ROUNDED TO THE NEAREST 100 LBS)	
a. PEACETIME/TRAINING MISSION	
Forward restraint	= <u>54500</u> lb
Vertical restraint	= <u>54500</u> lb
Port restraint	= <u>36300</u> lb
Starboard restraint	= <u>36300</u> lb
Aft restraint	= <u>36300</u> lb
b. HOSTILE FIRE MISSION	
Forward restraint	= <u>36300</u> lb
Vertical restraint	= <u>18200</u> lb
Port restraint	= <u>18200</u> lb
Starboard restraint	= <u>18200</u> lb
Aft restraint	= <u>18200</u> lb
4. INITIAL TIEDOWN REQUIREMENTS	
Forward restraint weight \rightarrow 35,000	= <u>2</u>
Vertical restraint weight \rightarrow 35,000	= <u>1</u>
Port restraint weight \rightarrow 35,000	= <u>1</u>
Starboard restraint weight \rightarrow 35,000	= <u>1</u>
Aft restraint weight \rightarrow 35,000	= <u>1</u>
5. TIEDOWN DIMENSIONS	
	CABLE 1 CABLE 2 CABLE 3 CABLE 4 CABLE 5
Angle \hat{a} in deg	<u>25</u> deg <u>30</u> deg <u>30</u> deg _____ deg _____ deg
Angle \hat{b} in deg	<u>25</u> deg <u>15</u> deg <u>70</u> deg _____ deg _____ deg
6. PERCENT RESTRAINT (REFER TO TABLE 4-4)	
	CABLE 1 CABLE 2 CABLE 3 CABLE 4 CABLE 5
Longitudinal (Forward/Aft) in %	<u>82</u> % <u>80</u> % <u>32</u> % _____ % _____ %
Vertical in %	<u>42</u> % <u>50</u> % <u>34</u> % _____ % _____ %
Lateral (Port/Starboard) in %	<u>38</u> % <u>22</u> % <u>88</u> % _____ % _____ %
7. RESTRAINT CABLE NUMBERS 1-5	
a. Restraint from cable in longitudinal (forward or aft) direction =	1 2 3 4 5
$\frac{(2) \times (35,000 \text{ lb}) \times (\text{longitudinal (forward or aft) \%})}{100} =$	lb <u>57400</u> <u>56000</u> <u>22400</u> _____ _____
b. Restraint from cable in vertical direction =	
$\frac{(2) \times (35,000 \text{ lb}) \times (\text{vertical \%})}{100} =$	lb <u>29400</u> <u>35000</u> <u>23800</u> _____ _____
c. Restraint from cable in lateral (port or starboard) direction =	
$\frac{(1) \times (35,000 \text{ lb}) \times (\text{lateral \%})}{100} =$	lb <u>13300</u> <u>7700</u> <u>30800</u> _____ _____



Angle Measurements to Determine Cargo Restraint

* When cable pairs are not symmetrical, calculate restraint for each individual cable.

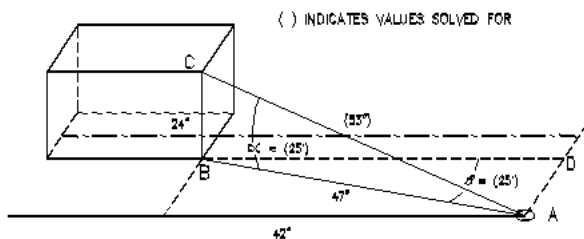
Figure 4-31 LCAC Restraint Calculation Worksheet Using Angle Measurements (Sample Problem)

- c. STEP 3. Enter vehicle weight of 36,300 pounds on line 2 (Figure 4-31).
- d. STEP 4. Calculate required restraint forces by multiplying vehicle weight (36,300 pounds) by required restraint on line 3a or 3b (Figure 4-31) as required (both have been entered for this sample problem). Also enter these requirements on the appropriate line of the cargo restraint summary sample problem form (Figure 4-32).

VEHICLE DESC./TAMCN #: <u>B2567/B0215</u> LCAC/MISSION: <u>SAMPLE</u> DATE: <u>JULY 93</u>					
CABLE NUMBER (PAIRS)	FORWARD RESTRAINT	AFT RESTRAINT	VERTICAL RESTRAINT	LATERAL RESTRAINT	
				PORT	STARBOARD
1	56000	57400	29400	13300	13300
2			35000	7700	7700
3		22400	23800	30800	30800
Totals 6	56000	79800	88200	51800	51800
REQUIREMENT	54500	36300	54500	36300	36300
HOSTILE FIRE					
1	56000	57400	29400	13300	13300
2			35000	7700	7700
Totals 4	56000	57400	64400	21000	21000
REQUIREMENT	36300	18200	18200	18200	18200

Figure 4-32 Cargo Restraint Summary for Angle Measurement (Sample Problem)

- e. STEP 5. Determine initial tiedown requirements by dividing required restraint by the maximum restraint of a tiedown (35,000 pounds) on line 4a and 4b (Figure 4-31). Peacetime/training are all 2 and hostile/fire all 1 except for forward restraint which is 2.
- f. STEP 6. Determine cargo tiedown placement points. Based on the initial number of cargo tiedowns required from step 5, (line 4a and 4b) one set of tiedowns is initially selected for the front and rear of the vehicle (cables 1 and 2 on Figure 4-30). If the angles are known, enter on lines 5 (Figure 4-31) and continue on to the next step.
- g. STEP 7. Find angle α & β . Since it is not possible to measure the angles for this problem without physically having the vehicle loaded on an LCAC, the mathematical model will be used to determine the angles. To do this it is necessary to know the length of the cables and the forward/aft, lateral and vertical distances. Using a distance of 10 1/2 inches between tiedown receptacles (determined by length of vehicle divided by the number of tiedowns it covers on the deck), the lateral distance is 21 inches and the forward and aft distance is 42 inches. The height of 24 inches is the distance from equipment tiedown to the deck. The distance of line AB is 47 inches, which is determined by measuring the distance in Figure 4-30 . Using the figure below, use the known distances and solve for the unknown side of each triangle ABC and ABD in order to find the values for angles α and β for cable 1.



With two sides of right triangle ABC known, that includes angle α , use the following formula to find the length of side AC.

$$AC = \sqrt{24^2 + 47^2}$$

$$AC = \sqrt{576 + 2209}$$

$$AC = 52.77$$

$$AC = 53 \text{ inches}$$

With all sides of the triangle known, use the following trigonometric formula for finding the angle α . Table 4-28 contains Table of Trigonometric functions.

Table 4-28 Trigonometric Functions

ANGLE	SINE
0	.000
5	.087
10	.174

Table 4-28 Trigonometric Functions (Cont.)

ANGLE	SINE
15	.259
20	.342
25	.423
30	.500
35	.574
40	.643
45	.707
50	.766
55	.819
60	.866
65	.906
70	.940
75	.966
80	.985
85	.996
90	1.000

$\sin \alpha = \text{opposite side} / \text{hypotenuse}$

$\sin \alpha = 24/53$

$\sin \alpha = .453$

$\alpha = \sin .453$ (see Table 4-28 or calculate)

$\alpha = 26.9$

$\alpha = 27^\circ$

Solve for angle β using the same process with all three sides already known solve for $\sin \beta$.

$\sin \beta = 21/47$

$\sin \beta = .447$

$\beta = \sin .447$

$\beta = 26.6^\circ$

$\beta = 27^\circ$

NOTE

The percentage restraint summary Table 4-27 is graduated in 5-degree increments. Therefore, when angles fall in between these values round off to the nearest 5-degree increments.

After rounding off angle $\alpha = 25$ degree and angle $\beta = 25$ degree.

Enter the values of 25 degree for both angle α and β under cable 1 on line 5.

- h. STEP 8. Find the percent restraint for tiedowns angles found in Step g. by referring to Table 4-27. The values are as follows:

- Longitudinal = 82%
- Vertical = 42%
- Lateral = 38%

Enter under cable 1 on line 6 (Figure 4-31).

- i. STEP 9. Using the restraint percentages of Step h. determine the restraint each cable provides in the longitudinal, vertical and lateral direction. The formulas are as follows:

Restraint in longitudinal (foreward and aft) direction

$(2) \times (35,000\text{lb}) \times (\text{foreward/aft } \% / 100) = \text{pounds longitudinal restraint}$

$(2) \times (35,000\text{lb}) \times 82/100 = 57,400\text{lb}$ (enter on line 7a Figure 4-31 and on form Figure 4-32)

Restraint in vertical direction

$(2) \times (35,000\text{lb}) \times (\text{vertical } \% / 100) = \text{pounds vertical restraint}$

$(2) \times (35,000\text{lb}) \times 42/100 = 29,400\text{lb}$ (enter on line 7b Figure 4-31 and on form Figure 4-32)

Restraint in lateral (port or starboard) direction

$(1) \times (35,000\text{lb}) \times (\text{lateral } \% / 100) = \text{pounds lateral restraint}$

$(1) \times (35,000\text{lb}) \times 38/100 = 13,300\text{lb}$ (enter on line 7c Figure 4-31 and on form Figure 4-32)

- j. STEP 10. Repeat Steps f., g., h., and i. for all tiedowns until adequate restraint is provided for TAMCN B2567/B0215.

While solving this sample problem, using the above procedures, it was determined that after adding, cable pair number 2 to the aft end of the vehicle there was still a shortage in restraint in the lateral direction for peacetime/training missions. Because of this cable pair number 3 was added. All values were entered on the appropriate lines of Figures 4-31 and 4-32. The hostile fire restraints were taken directly from the peacetime/training calculations.

4-4.4.3. Cargo Tiedown Calculation Procedures Using Distance Measurements An illustration of the distance measurements for a single tiedown is provided in Figure 4-33. Figures 4-34 and 4-29 are examples of the forms used to calculate and record cargo restraints. Except for a straight pull parallel to the deck and at a right angle to the cargo, each tiedown will provide restraint in three directions: forward or aft, athwartship, and vertically. The amount varies with the distance of the tiedown.

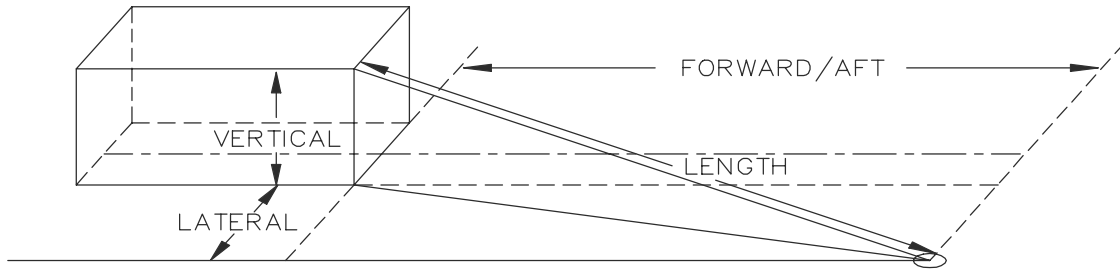
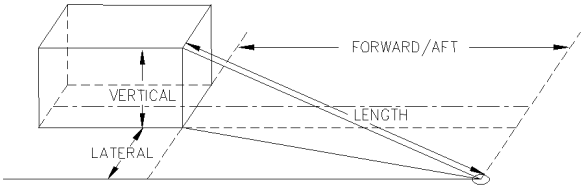


Figure 4-33 Distance Measurements to Determine Cargo Restraint

1. VEHICLE DESCRIPTION/TAMCN #: _____	DATE: _____				
2. CARGO WEIGHT _____ lb					
3. REQUIRED RESTRAINT FORCES <i>(ROUNDED TO THE NEAREST 100 LBS)</i>					
a. PEACETIME/TRAINING MISSION					
Forward restraint	=	1.5 x cargo weight = _____ lb			
Vertical restraint	=	1.5 x cargo weight = _____ lb			
Port restraint	=	1 x cargo weight = _____ lb			
Starboard restraint	=	1 x cargo weight = _____ lb			
Aft restraint	=	1 x cargo weight = _____ lb			
b. HOSTILE FIRE MISSION					
Forward restraint	=	1 x cargo weight = _____ lb			
Vertical restraint	=	0.5 x cargo weight = _____ lb			
Port restraint	=	0.5 x cargo weight = _____ lb			
Starboard restraint	=	0.5 x cargo weight = _____ lb			
Aft restraint	=	0.5 x cargo weight = _____ lb			
4. INITIAL TIEDOWN REQUIREMENTS					
Forward restraint weight ÷ 35,000	=	A. PEACETIME/TRAINING _____ B. HOSTILE FIRE _____			
Vertical restraint weight ÷ 35,000	=	_____			
Port restraint weight ÷ 35,000	=	_____			
Starboard restraint weight ÷ 35,000	=	_____			
Aft restraint weight ÷ 35,000	=	_____			
5. TIEDOWN DIMENSIONS					
	CABLE 1	CABLE 2	CABLE 3	CABLE 4	CABLE 5
Length of cable	_____ in	_____ in	_____ in	_____ in	_____ in
Length of cable in forward/aft direction	_____ in	_____ in	_____ in	_____ in	_____ in
Length of cable in vertical direction	_____ in	_____ in	_____ in	_____ in	_____ in
Length of cable in port/starboard direction	_____ in	_____ in	_____ in	_____ in	_____ in
6. RESTRAINT CABLE NUMBER					
a. Restraint from cable in longitudinal (forward or aft) direction =					
* $(2)(35,000 \text{ lb}) \frac{\text{length of cable in longitudinal (forward or aft direction)}}{\text{length of cable}}$ 1 2 3 4 5					
_____ lb _____ lb _____ lb _____ lb _____ lb					
b. Restraint from cable in vertical direction =					
* $(2)(35,000 \text{ lb}) \frac{\text{length of cable in vertical direction}}{\text{length of cable}}$ _____ lb _____ lb _____ lb _____ lb _____ lb					
c. Restraint from cable in lateral (port or starboard) direction =					
* $(1)(35,000 \text{ lb}) \frac{\text{length of cable in lateral direction}}{\text{length of cable}}$ _____ lb _____ lb _____ lb _____ lb _____ lb					



Distance Measurements to Determine Cargo Restraint

** When cable pairs are not symmetrical, calculate restraint for each individual cable.*

Figure 4-34 LCAC Restraint Calculation Worksheet Using Distance Measurements

- a. Determine cargo weight in pounds (lbs), and enter on line 2 of Figure 4-34 .
- b. Determine the required restraint in the forward, vertical, lateral (port and starboard), and aft directions by multiplying the cargo weight by the peacetime/training restraint criteria line 3a (Figure 4-34) or the hostile fire restraint criteria line 3b (Figure 4-34) as appropriate. Enter this data in the appropriate columns of the Cargo Restraint Summary, Figure 4-29 .
- c. Make an initial determination of the number of tiedowns required. Divide the restraint required (values calculated in Step b.) by 35,000 pounds and list on line 4 of Figure 4-34 . Always use an even number of tiedowns in each restraint direction (use tiedowns in pairs). When number of tiedowns is not a whole number, always round up to the next whole number (e.g., 4.1 is rounded up to 5). When an odd number of tiedowns is calculated, increase the number by 1. Tie down the cargo with this number of tiedowns.

NOTE

Cable restraint is calculated in pairs, except when cables are not symmetrical.

- d. Determine the restraint applied by an individual set of cables. Measure the distances indicated in Figure 4-30 , and enter the amount in inches on line 5 of Figure 4-34 .
 - The length of cable is from the tiedown point on the cargo to the tiedown point on the LCAC. The length of cable in the forward or aft direction is measured along the deck, parallel to the tiedown rails. The length of cable in the vertical direction is measured straight up from the deck to the tiedown point on the cargo. The length of cable in the port or starboard direction is measured along the deck, perpendicular to the tiedown rails.
- e. When dealing with heavy cargo, number the cables to minimize confusion. Record cable lengths on line 5 of Figure 4-34 .
- f. Next determine the cable restraint in each direction. The working strength of an individual cable is 35,000 pounds. Since the restraint of the cables is for a pair, multiply by two in the forward/aft and vertical directions. Multiply by one in the port/starboard direction because these cables counteract each other. Perform the calculated restraint for each direction on line 6a, b, and c of Figure 4-34 , and in the appropriate columns of Figure 4-29 .
- g. Total all numbers in all columns on the Cargo Restraint Summary, Figure 4-29 .

As indicated in Figure 4-29 the sum of the restraint of all cables is used to meet the total restraint requirements. Compare the totals in Figure 4-29 to the required restraint forces. If the totals are equal to or larger than the required restraint forces then the cargo is adequately restrained. If not, begin adding tiedowns in the appropriate direction until the totals equal or exceed the required restraint forces. If the totals exceed the restraint requirements, the number of tiedowns may be reduced by pairs of tiedowns.

4-4.4.4. Sample Problem Using the distance measuring method, develop a restraining plan for the TRAM vehicle, TAMCN B2567/B0647 (fork). This is the same vehicle as in the previous sample problem with exception of a fork vice a bucket on the front and 400-pound increase in weight.

- a. STEP 1. Position vehicle on the cargo deck. For illustrative purposes, an overhead view of the vehicle is placed on a blank cargo deck as is used in the pocket handbook (Figure 4-30).
- b. STEP 2. Enter vehicle description/TAMCN B2567/B0647 on line 1 of distance measurement sample worksheet (Figure 4-35).

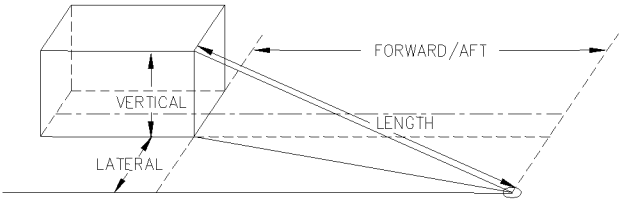
1. VEHICLE DESCRIPTION/TAMCN #: <u>B2567/B0647</u>	DATE: <u>July 93</u>
2. CARGO WEIGHT <u>36700</u> lb	
3. REQUIRED RESTRAINT FORCES (ROUNDED TO THE NEAREST 100 LBS)	
a. PEACETIME/TRAINING MISSION	
Forward restraint	= 1.5 x cargo weight = <u>55100</u> lb
Vertical restraint	= 1.5 x cargo weight = <u>55100</u> lb
Port restraint	= 1 x cargo weight = <u>36700</u> lb
Starboard restraint	= 1 x cargo weight = <u>36700</u> lb
Aft restraint	= 1 x cargo weight = <u>36700</u> lb
b. HOSTILE FIRE MISSION	
Forward restraint	= 1 x cargo weight = <u>36700</u> lb
Vertical restraint	= 0.5 x cargo weight = <u>18400</u> lb
Port restraint	= 0.5 x cargo weight = <u>18400</u> lb
Starboard restraint	= 0.5 x cargo weight = <u>18400</u> lb
Aft restraint	= 0.5 x cargo weight = <u>18400</u> lb
4. INITIAL TIEDOWN REQUIREMENTS	
Forward restraint weight ÷ 35,000	= <u>2</u>
Vertical restraint weight ÷ 35,000	= <u>1</u>
Port restraint weight ÷ 35,000	= <u>1</u>
Starboard restraint weight ÷ 35,000	= <u>1</u>
Aft restraint weight ÷ 35,000	= <u>1</u>
5. TIEDOWN DIMENSIONS	
	CABLE 1 CABLE 2 CABLE 3 CABLE 4 CABLE 5
Length of cable	<u>53</u> in <u>92</u> in <u>66</u> in _____ in _____ in
Length of cable in forward/aft direction	<u>42</u> in <u>78</u> in <u>21</u> in _____ in _____ in
Length of cable in vertical direction	<u>24</u> in <u>44</u> in <u>24</u> in _____ in _____ in
Length of cable in port/starboard direction	<u>21</u> in <u>21</u> in <u>58</u> in _____ in _____ in
6. RESTRAINT CABLE NUMBER	
a. Restraint from cable in longitudinal (forward or aft) direction =	1 2 3 4 5
* (2)(35,000 lb) (length of cable in longitudinal (forward or aft direction) ÷ length of cable)	<u>55500</u> lb <u>59300</u> lb <u>22300</u> lb _____ lb _____ lb
b. Restraint from cable in vertical direction =	
* (2)(35,000 lb) (length of cable in vertical direction ÷ length of cable)	<u>31700</u> lb <u>33500</u> lb <u>25500</u> lb _____ lb _____ lb
c. Restraint from cable in lateral (port or starboard) direction =	
(1)(35,000 lb) (length of cable in lateral direction ÷ length of cable)	<u>13900</u> lb <u>8000</u> lb <u>30800</u> lb _____ lb _____ lb
	
Distance Measurements to Determine Cargo Restraint	
* When cable pairs are not symmetrical, calculate restraint for each individual cable.	

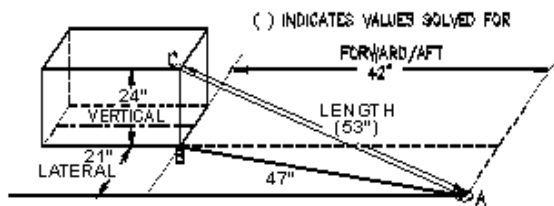
Figure 4-35 LCAC Restraint Calculation Worksheet Using Distance Measurements (Sample Problem)

- c. STEP 3. Enter vehicle weight of 36,300 pounds on line 2 (Figure 4-35).
- d. STEP 4. Calculate required restraint forces by multiplying vehicle weight (36,300 pounds) by required restraint on line 3a or 3b (Figure 4-35) as required (both have been entered for this sample problem). Also enter these requirements on cargo restraint summary sample problem (Figure 4-36).

VEHICLE DESC.: <u>B2567/B0647</u> LCAC/MISSION: <u>SAMPLE</u> DATE: <u>JUN 93</u>					
CABLE NUMBER (PAIRS)	FORWARD RESTRAINT	AFT RESTRAINT	VERTICAL RESTRAINT	LATERAL RESTRAINT	
				PORT	STARBOARD
1	59300	55500	31700	13900	13900
2			33500	8000	8000
3		22300	25500	30800	30800
<i>Totals</i>	59300	77800	90700	52700	52700
<i>REQUIREMENT</i>	55100	36700	55100	36700	36700
HOSTILE FIRE					
1	59300	55500	31700	13900	13900
2			33500	8000	8000
<i>Totals</i> 4	59300	55500	65200	21900	21900
<i>REQUIREMENT</i>	36700	18400	18400	18400	18400

Figure 4-36 Cargo Restraint Summary for Distance Measurements (Sample Problem)

- e. STEP 5. Determine initial tiedown requirements by dividing required restraint by the maximum restraint of a tiedown on line 4a and 4b (Figure 4-36). Peacetime/ training requirement are all 2 with hostile fire all 1 except for forward restraint which is 2.
- f. STEP 6. Determine cargo tiedown placement points. Based upon the initial number of tiedown required from Step e. line 4a and 4b (Figure 4-35), initially place one pair of tiedowns at each end of the vehicle (cable 1 and 2, Figure 4-30) and determine the length. Unless the cables are physically attached to a vehicle on the cargo deck the actual cable length will have to be determined mathematically. The length of cable in the longitudinal (forward/aft), vertical, and lateral (port and starboard) can be determined by using a pair of dividers and a scale determined by the length of the vehicle divided by the number of tiedown receptacles. In this case, 10 1/2 inches per receptacle. The length of cable in longitudinal direction is 42 inches, vertical direction is 24 inches and lateral direction is 21 inches. Find the length of line AC.



The distance of line AB (47 inches) is found by measuring the distance on Figure 4-30 . With 2 sides of the right triangle ABC known solve for line AC using the formula.

$$AC = \sqrt{24^2 + 47^2}$$

$$AC = \sqrt{576 + 2209}$$

$$AC = 52.77$$

$$AC = 53 \text{ inches}$$

Enter the following distances (in Table 4-29) for cable 1 on line 5 (Figure 4-35).

Table 4-29 Distances for Cable 1

Distances	
Cable Length	= 53 inches
Longitudinal	= 42 inches
Vertical	= 24 inches
Lateral	= 21 inches

- g. STEP 7. Calculate restraint for all directions using the following formula:

Restraint in longitudinal (foreward and aft) direction

$(2) \times (35,000\text{lb}) \times (\text{length of cable in longitudinal direction} / \text{length of cable})$

$(2) \times (35,000\text{lb}) \times 42/53 = 55,471$ or 55,500lbs (enter on line 6a Figure 4-35 and on form Figure 4-36)

Restraint in vertical direction

$(2) \times (35,000\text{lb}) \times (\text{length of cable in vertical direction} / \text{length of cable})$

$(2) \times (35,000\text{lb}) \times 24\%/53 = 31,698$ or 31,700lbs (enter on line 7b Figure 4-31 and on form Figure 4-32)

Restraint in lateral (port or starboard) direction

$(1) \times (35,000\text{lb}) \times (\text{length of cable in lateral direction} / \text{length of cable})$

$(1) \times (35,000\text{lb}) \times 21/53 = 13,868$ or 13,900lbs (enter on line 6c Figure 4-35 and on form Figure 4-36)

- h. STEP 8. Repeat Steps f. and g. for all tiedowns until adequate restraint is provided for TAMCN B2567/B0647.

For this sample problem, the remaining calculations were completed for a sufficient number of tiedowns with the data appropriately recorded.

NOTE

Even though the same tiedowns were used for both sample problems it is noted that the calculated restraint values differ for each method. This is accounted for in that the angle method is somewhat less accurate because the angle values are listed in 5 % increments whereas the measurements method is based on specific measurements. However, in any event, either method can be used safely to restrain LCAC cargo.

4-4.5. Methods Of Restraining Cargo There are two basic methods of applying tiedowns to restrain cargo. The method used depends upon whether or not the cargo has tiedown provisions. Cargo with no tiedown provisions is restrained by cargo nets, or in some cases, by aircraft type 15-foot nylon straps (CGU-1/B) shown in Figure 4-37. It has a fixed snaphook on one end, and a moveable hook with a ratchet-type tension lever on the other. These cargo straps are not a part of the craft allowance list and must be procured separately.

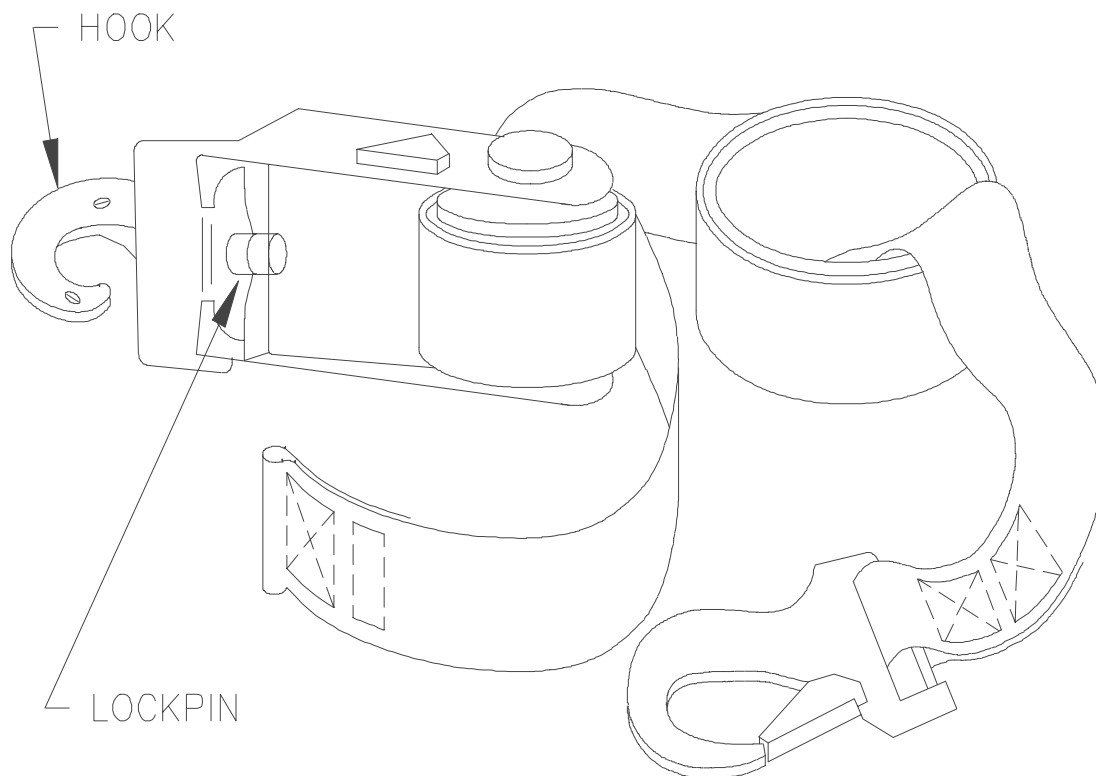


Figure 4-37 CGU-1/B 5,000-Pound Capacity Tiedown Device

Cargo with tiedown provisions is restrained by attaching one end of the tiedown device to the tiedown fittings in the cargo deck, and the other end of the tiedown device to the tiedown point on the cargo.

4-4.6. Restraint Of Cargo Without Tiedown Provisions Many cargo loads carried will consist of a variety of containers. This type of cargo must be secured by passing tiedown devices over and around the cargo. When cargo is restrained in this manner, there are three factors that must always be kept in mind:

a. Amount of restraint.

A tiedown device placed around an item of cargo will provide restraint equal to the effective strength of the device and/or the tiedown fitting in the direction it prevents the cargo from moving. The individual devices applied will provide restraint in one direction only. Restraining devices should be applied against movement in each direction; forward, aft, port, starboard, and vertical.

b. Length and tiedown angle of the tiedown devices.

A tiedown device generally should always be as short as possible and follow as closely as possible the contour of the cargo it is securing, to minimize slippage. When there are more than two devices in the fore-and-aft direction the tiedown angle of additional devices on the aft side of the cargo should be changed to 45 degree, to obtain additional protection against any tendency of the cargo to tumble forward. This procedure is particularly important when tying down tall items and composite loads consisting of several containers that are stacked. In

arranging composite loads, cargo should not be stacked so that it is top-heavy. The height of a composite load should not be greater than its length in the longitudinal direction, if it can be avoided. Nets may be used to provide adequate tiedown devices and to minimize slippage of composite cargo.

c. Shift of cargo.

Since the tiedown devices are not actually attached to the cargo, care must be taken to ensure that the load cannot slip out from under the tiedown devices. This is especially true when several items are tied down together. After the correct number of tiedowns have been applied to provide the required restraint, the load should always be checked to see if any part of it can slip free. In many instances where several items are tied down together, it may be necessary to add additional tiedowns to completely secure the load.

4-4.7. Restraint Of Cargo With Tiedown Provisions Vehicles, special shipping containers, and some items of equipment are provided with rings or other suitable points to which cargo tiedown devices can be attached. This type of cargo should be secured as shown in Vehicle Loading Pocket Handbook. When cargo is secured by attaching tiedown devices directly to the cargo, there are two factors that must be kept in mind:

a. Applied restraint.

A tiedown device, attached between a tiedown ring or point on an item of cargo and a tiedown receptacle in the cargo deck, will provide restraint equal to the strength of the tiedown in the direction of the tiedown device. In practice, however, it is not feasible to attach tiedown devices purely in the direction in which restraint is required because of the location of the tiedown provisions on the cargo. Most tiedowns out of necessity must be attached at an angle to the desired direction of restraint, and consequently only a part of the effective strength of the tiedown will be available to provide restraint in the desired direction as discussed in cargo tiedown calculation procedures.

b. Tiedown angle.

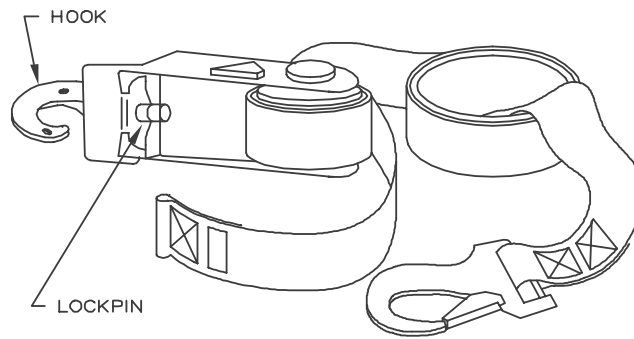
The tiedown angle is very important and must be considered since it determines the amount of restraint which can be obtained in any direction. To minimize the number of tiedowns, the tiedowns should be applied with both a vertical and a side angle in order to provide restraint in three directions.

4-4.8. Container Tiedown Securing of ISO containers to the deck of the LCAC may be accomplished with the use of existing tiedown rails and 35,000-pound tiedown assemblies. One end of the assembly attaches to a corner of a container, and the other fits into the socket on the tiedown rail providing the most optimum lead. Only 20-foot ISO containers and MCESS containers will be carried. Characteristics of each type are listed in Table 4-30. Containers may be stowed either fore and aft or athwartships, and the number of tiedowns required to secure the container must be calculated. Dunnage is also required to be used when loading containers on the LCAC deck.

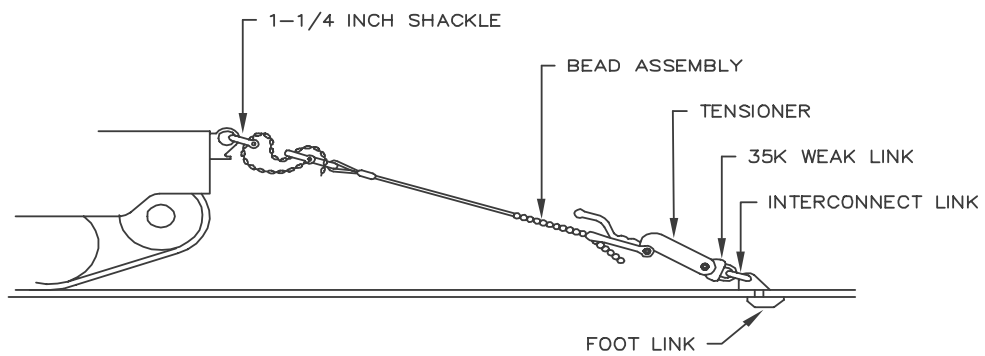
Table 4-30 ISO Standard and MCESS Container Dimensions

CONTAINER TYPE	LENGTH (Feet)	WIDTH (Feet)	HEIGHT (Feet)	MAXIMUM GROSS WEIGHT (Pounds)
ISO Type ICC	20	8	8.5	44,806
ISO Type IC	20	8	8	44,806
MCESS Rigid (TAMCN C6122)	20	8	8	15,000
MCESS Knock Down (TAMCN C6113)	20	8	8	15,000
MCESS EMI (TAMCN C6112)	20	8	8	15,000

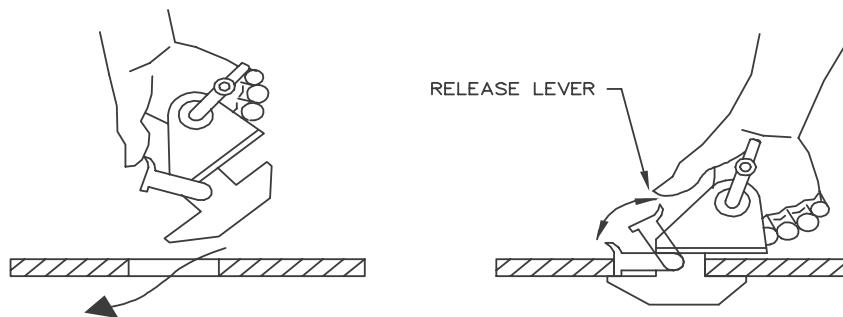
4-4.9. Tiedown Device Operation For operation of tiedown devices, see Figure 4-38. The capacity of a tiedown device is limited to the capacity of the tiedown fitting and strength of the cargo attaching points.



CGU-1/B TIEDOWN



35,000-POUND TIEDOWN ASSEMBLY



LCAC DECK FITTING

Figure 4-38 Cargo Tiedowns

The deck fitting assembly is key-fitted into deck tiedown rails. Figure 4-38 shows insertion of deck fitting into socket. The keeper shall be up when inserting the deck fitting and down when locked-in. After installing the deck fitting, place the chain bridle around the vehicle lashing point. In the event a tiedown point is not provided, a structural member of sufficient size and strength (e.g., vehicle bumpers and/or chassis tiedown points) may be used by bridling the chain and attaching to the cable assembly grab link. After attaching the chain to the cargo, release tensioner handle. Remove slack in cable assembly, and select number of spacer beads required. Slide tensioner adapter onto cable above spacer beads. Lift up on tensioner handle and push forward to lock. If there is not enough tension on cable assembly, release handle and remove tensioner assembly from cable. Slide as many spacer beads as required down cable and reattach tensioner adapter to cable. Lift up on handle and lock in place. If handle cannot be locked in place, release tensioner from cable and slide a few spacer beads at a time up cable until lock tensioner handle will lock.

The CGU-1/B 5,000-pound capacity tiedown device operates in the following manner. Attach hook to tiedown deck fitting. Open unit and pull webbing through the cylinder. Work ratchet to tighten webbing. Lock handle in position in direction of hook. Loosen by squeezing spring-loaded lockpin in ratchet handle and pull webbing.

The embarked troop unit is responsible for performing the actual securing of cargo on the craft under the supervision of the Loadmaster. Care must be taken when tying to vehicle frames, axle housings, or attachment points in order to prevent damage to the vehicle's brake lines, hydraulic lines, electrical wiring, or other components. The Loadmaster will ensure all tiedowns are properly placed and secured.

4-4.10. **Cargo Protection** United States Marine Corps (USMC) amphibious vehicles have been experiencing increasing levels of corrosion when embarked or preloaded on LCAC. Covers for the LAV and M198 Howitzer were developed by the First Marine Expeditionary Force (IMEF) for use onboard LCAC to limit the effects of salt-water corrosion. These covers, if not properly secured, are potential material for foreign object damage to LCAC propellers. These covers shall be used only on preloaded equipment. The covers shall be removed prior to any shore movement. See Chapter 5 for specific procedures.

4-5. **CARGO OFFLOADING**

4-5.1. **General Considerations For Offloading Cargo** Offloading procedures are similar to loading procedures previously discussed in this section. Offloading of cargo can be expedited by assembling necessary unloading aids (as required) in the area of the cargo offloading. The equipment required for offloading is essentially the same as that required for loading a specific load (i.e., crane, forklift, shoring, etc.).

The method selected for offloading vehicles and other cargo items will depend upon: (1) where they were loaded (from mother ship or shore-based supply point); (2) how they were loaded (by crane or driven); (3) how they will be offloaded (by crane or driven across bow or stern ramps); and (4) where they will be offloaded (into well deck, water, or ashore). A correct loading sequence ensures adequate clearance for offload maneuvering. The craft may be positioned to permit a bow, stern, or bow and stern ramp exit as needed.

General procedures for offloading the craft, after it has come to a complete stop, are as follows.

- a. Shut down main engines.



Prior to bow or stern ramp operations ensure the area around the ramps is clear of debris and personnel so as to not damage the craft or cause injury to personnel when the ramps are lowered or raised.

- b. Remove tiedowns, and clear vehicle lanes.
- c. Lower ramp.
- d. Deploy dunnage as necessary.
- e. Offload vehicles and cargo (loadmaster assisted unless in combat mission).
- f. Disembark passengers.
- g. Stow all cargo tiedowns unless picking up a backload.
- h. Inspect cargo deck for FOD.
- i. Raise ramp.
- j. Continue mission.

4-5.2. Offloading Ashore For offloading vehicles ashore, the vehicles on the craft will be positioned so that they may be offloaded in the most expeditious manner. All vehicles will be capable of driving off the craft under their own power (towed loads coupled with prime mover), but support vehicles may be required to tow inoperative vehicles. The offloading ramp must be supported equally by the ground.

4-5.3. Offloading Shipboard LCAC shall be offloaded under the direction of the ship's cargo handling organization. Crew and embarked troops shall not depart LCAC while another LCAC in a forward well deck position is operating its main engines.

Offload of cargo from LCAC to support ship depends on the ship configuration, position and condition of the cargo, as well as LCAC refueling requirements. Cargo may be lifted off the deck, driven off under its own power, or removed via forklifts.

4-5.4. Offloading/Transfer At Sea When at sea transfer of people or equipment is required, the craft shall be hullborne. The craft may be at bare steerageway or dead in the water, as is appropriate to the situation. Transfer may be conducted at either forward linehandler's station or from the lowered stern ramp. Transfer at the starboard linehandler's station is preferable in order to allow the Craftmaster continuous observation of the transfer.

Since the stern ramp floats, all slack in the stern ramp cable shall be pulled from the pedestal. This allows the ramp to float free without damage. A tight cable may part as the ramp moves with the sea. The number of personnel on the ramp shall be kept to a minimum and only for short periods of time.

- Crane loads shall be tended and controlled by the Loadmaster and other crewmen, as assigned.
- Personnel working on the cargo deck when offloading with the main engines turning shall be reduced to a minimum.
- The bow ramp shall not be lowered at sea except in the event of an emergency.
- Individuals working on the ramp shall be in a life jackets..

4-5.5. Troop Offloading Troops carried in the LCAC passenger compartments or in PTM are offloaded at the direction of the Loadmaster/Craftmaster. Normally all troops are disembarked by way of the bow ramp.

4-5.6. Litter Offloading Litters carried in the PTM are offloaded at the direction of the Loadmaster/Craftmaster, in coordination with medical regulating authority. All litters are normally disembarked by way of the bow ramp.

4-5.7. Offloading To Support Ship Following an amphibious training operation, cargo loaded from the support ship normally will be returned for stowage. How the cargo will be offloaded at the support ship depends upon the ship's configuration, refueling requirements, and the position and condition of the cargo to be offloaded.

For example, in the LSD 36 Class, the forward well deck vertical clearance is limited by a mezzanine deck. Vehicles move between the super and well decks via ramps. With the mezzanine deck in place, forward movement of the LCAC within the well deck is precluded by the lower ramp. In this class of ship, mezzanine deck and ramps can be removed (in port) to permit transport of additional LCAC. In this configuration, the support ship deck cranes and overhead monorails are accessible for offloading cargo. The support ship centerline capstan may be required to assist offloading of disabled vehicles. If the craft must be refueled, craft position in the well deck may also be dictated by the location of fueling stations in the support ship.

The following are basic precautions for offloading LCAC cargo to a support ship:

- Crane loads will be controlled by the Loadmaster and tended by personnel assigned.
- Personnel working on the cargo deck when offloading with the main engines turning shall be reduced to a minimum.

When backloading the LCAC on the beach, vehicles with a tow can be loaded with the front of the prime mover facing the bow of the craft. This allows the vehicle and tow to offload straight onto the well deck instead of having to back off the craft.

4-5.8. Through Craft Loading The separation between any two LCAC for vehicle through-loading is critical to ensure correct overlap of the stern ramp of the forward craft on the bow ramp of the after craft, without causing skirt damage. The proper separation is approximately 8 feet. Following correct positioning of both craft, the craft should be brought off the cushion and the stern ramp of the forward LCAC shall be lowered onto the bow ramp of the after craft. Care should be taken to avoid trapping and damaging either skirt bag.

Certain vehicles, such as the M923 Truck/M198 Howitzer combination, require a lesser angle between the bow and stern ramps in order to achieve adequate ground clearance. The use of shoring under the

stern ramp will provide satisfactory clearance. It is recommended that approximately 6-12" of shoring is placed under the bow ramp and the stern ramp is placed over the bow ramp. However, the procurement of Super Single Tires (SST) for the M923 truck has increased the ground clearance slightly and provides adequate through-loading clearance when towing the M198 Howitzer.

4-5.9. After Offloading When offloading operations are completed, the Cargo Deck should be cleaned and prepared for the next mission.

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CHAPTER 5

SPECIFIC PROCEDURES

5-1. GENERAL

This chapter provides information on cargo items that require special handling or operational procedures when being carried or operated on LCAC.

5-2. LAV COVER PROCEDURES

- a. Inspect all covers, netting, and straps for deterioration, rips, or tears prior to use.



Ensure heat-emitting areas have cooled prior to covering vehicles.

- b. Place canvas tarp over turret starting mid-barrel working to the rear to troop hatch covering all top corners/edges at rear of LAV and secure.
- c. Stretch prefabricated herculite cover out alongside the LAV.
- d. Pull the cover from side over LAV and align mid-seam with middle of vehicle. Check overall fit and ensure correct hang on each side.
- e. Zip up the rear of cover (handle zipper area with care).
- f. Pull draw strings evenly and ensure cover wraps props.
- g. Pull ropes to opposite sides (port to starboard/starboard to port) and tie ropes around proper shaft. Do not cover shackles.
- h. Stretch out net alongside LAV (Note: The black straps on net are lifting legs).
- i. Pass lifting legs to Marine on vehicle. Area to cover: from 6 inches to 12 inches below Herculite cover on trim vane to rear reaching behind turret hatches. The net should hang evenly on both sides. Front lifting legs will drape front comers, rear-lifting legs will not hand over rear corners; they will drape near the third tire from front.
- j. Pull rear lifting legs to the rear of the vehicle. Attach port hook to starboard leg strap that provides most tension. Disperse rear-lifting legs on port/starboard sides (two leg straps above top rear comer and two below along sides). The top strap port and starboard should cross bussel rack.
- k. Run green cargo strap (first) beneath the vehicle length wise-hooking to the center of net in the front and hooking on a secure lifting leg from the rear. Ensure straps run properly beneath LAV and remove slack.
- l. The next (second) green strap will be used to pull the net from two points, the top of turret to a secure leg strap on rear troop hatch (in a "V" configuration).

- m. Attach (third) green strap to port side net between the two middle wheels. Pull underneath directly opposite the starboard side, loop strap through the net, and feed back under diagonally to front port side corner netting. Attach (fourth) green strap on starboard side of net between first and wheel from front. Pull underneath directly to the opposite side (port) between the first and second wheels from the front. Loop through the net and hook in starboard front corner netting on trim vane.
- n. Pick up the front lift legs. The starboard lifting legs will be pulled tightly and wrapped along netting on lower trim vane to port side and hooked with leg hook (tuck in loose leg straps). The same process must be completed with the port side lifting legs.
- o. The final (fifth) green strap will be fully extended, running from the net near second tire from front just above Herculite cover around the side draping under trim vane, weaving it as necessary to secure any flapping pieces, and attaching to the same place on opposite side.



LAV crews should not be stationed inside the LAV with covers installed.

- p. During initial operations, maintain a close watch on the covers. Come off cushion and resecure the nylon straps as required to preclude billowing.

5-3. **M198 HOWITZER COVER PROCEDURES**

Underway tests and previous operational experience with the M198 cover indicate it is satisfactory for use aboard LCAC with the following precautions.

- a. The M198 Howitzer cover may come loose from the muzzle brake and can be secured with the use of duct tape.
- b. Care must be exercised to prevent undue stress on gun covers that may cause seams to rip and allow the cover to become FOD material.

5-4. **M1A1 TIEDOWN PROCEDURES**

5-4.1. **M1A1 Tiedown** The weight of the M1A1 Main Battle Tank requires numerous tiedowns to ensure safe transport aboard LCAC. In order to reduce the time required for installation and removal of the tiedowns, special adaptive hardware has been developed for use on the M1A1. The hardware consists of four 1.25" Crosby screw type shackles and two welded rings installed onto the tank's front attachment rings, as shown in Figure 5-1. The rear hardware consists of a 1.75" pear link that is attached over the tow pintle as shown in Figure 5-2. All of this additional hardware is installed on the tank prior to transport and removed prior to offload. Installation of the tiedowns is the same as for other vehicles, i.e., once the tank is in position on the LCAC all tiedowns are attached. The removal process is modified to save time by first removing the front tiedowns and attaching hardware then the tank is started and backed up approximately 12 inches. The pear link can then be removed from the tank without removing the tiedowns.



Figure 5-1 M1A1 Front Welded Rings and Shackles

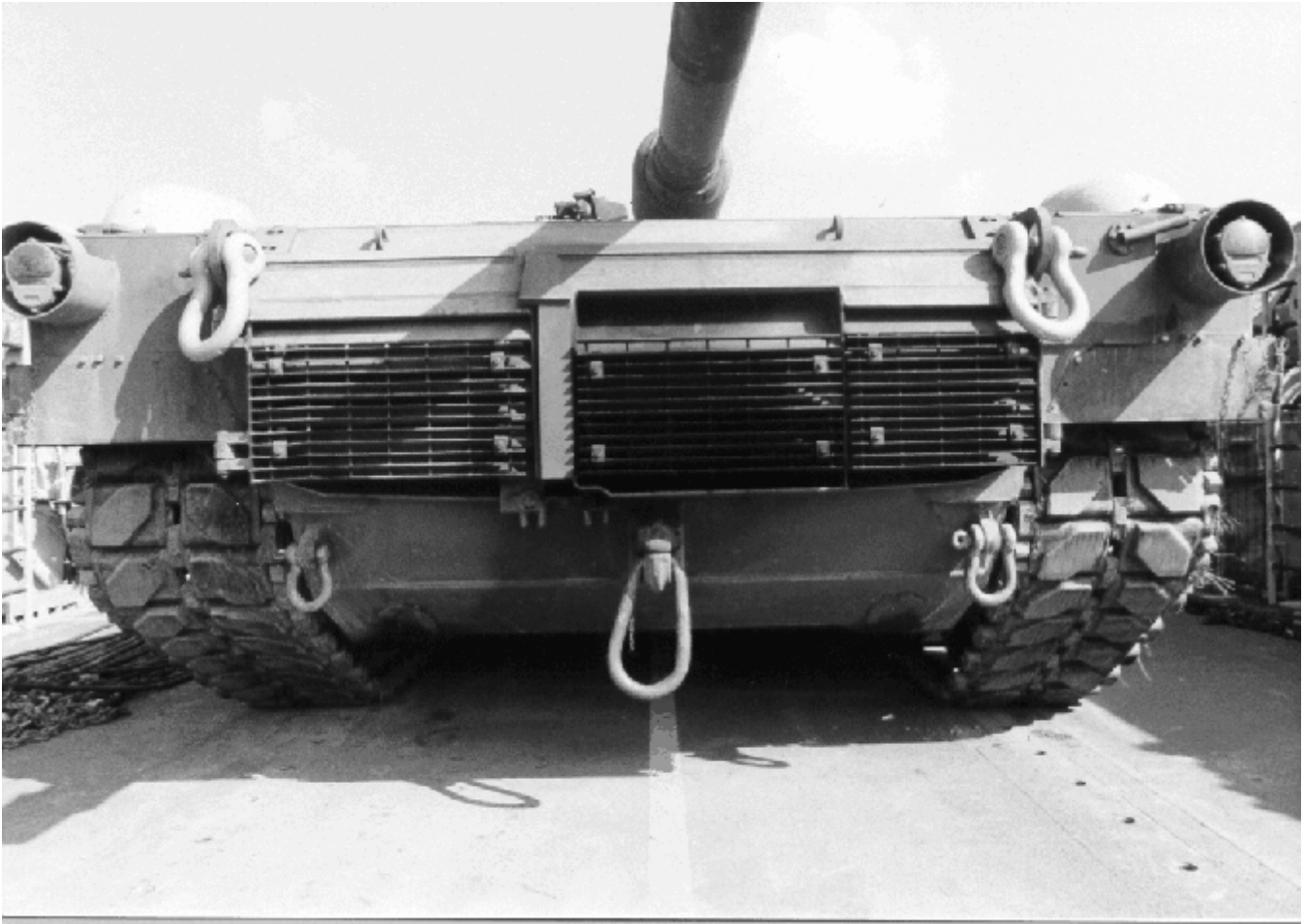


Figure 5-2 Aft Pear Link Assembly



Strict adherence to director signals shall be observed by the tank driver when backing up to ensure that equipment is not damaged and personnel not injured when removing the aft pear link assembly.

After offloading the tank all tiedowns and attaching hardware shall be removed from the cargo deck and properly stowed. M1A1 tiedown arrangements for both peacetime/training and hostile fire missions, as taken from the Vehicle Loading Pocket Handbook, are shown in Figure 5-3.

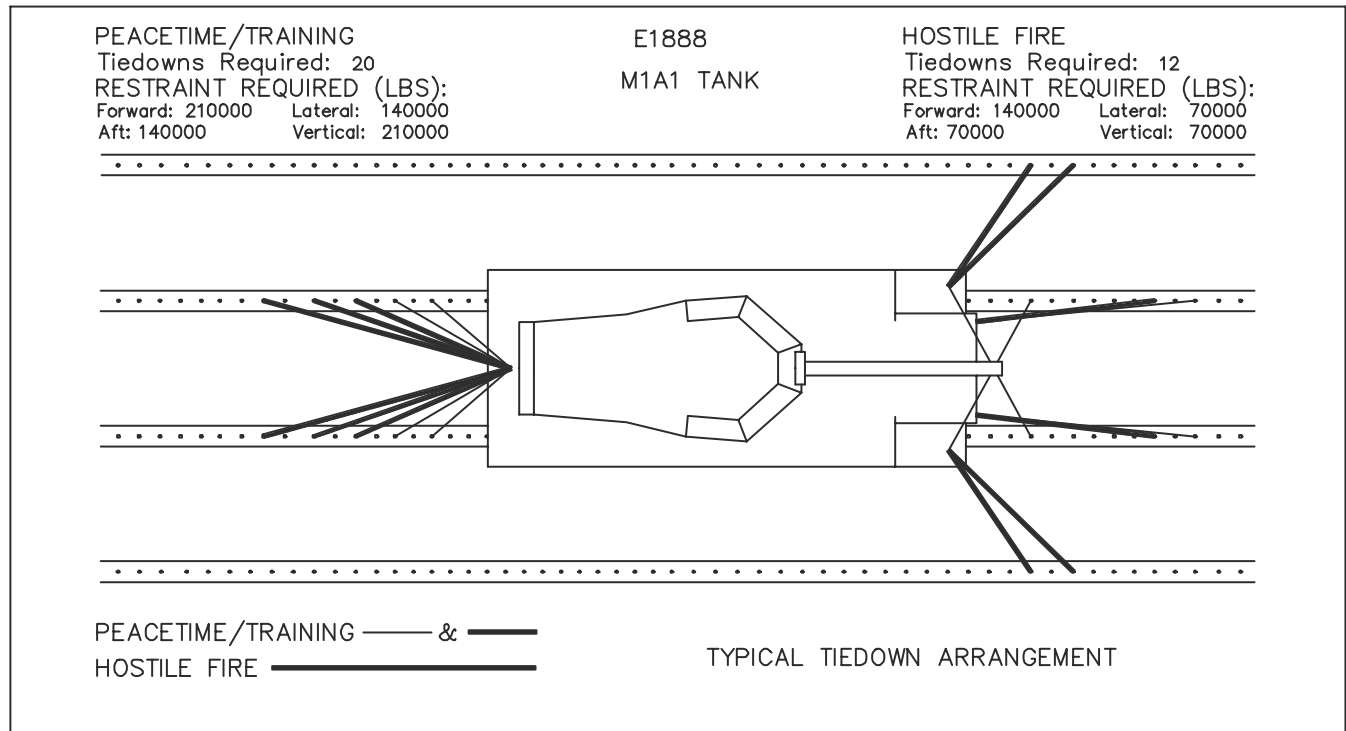


Figure 5-3 Peacetime/Training and Hostile Fire Tiedown Arrangement for the M1A1

5-4.2. **Onloading And Offloading M1A1 With Mineplow** Onloading and offloading LCAC with a mineplow configured M1A1 requires shoring when accomplished from a hard surface or well deck. Shoring is not required when operating on sand or other soft surface. The LCAC bow ramp angle must be reduced to prevent the mineplow from contacting the hard surface of the ramp or ship deck. The ramp to hard surface interface point must be raised by 12 inches. This can be accomplished by raising the ramp 12 inches supported with shoring. The LCAC ramp is extended by additional shoring. Alternatively, a combination of raising the ramp less than 12 inches and placing additional shoring on top of the ramp will accomplish the same result. Recommended shoring material is railroad ties, but other suitable heavy timbers may be used.

5-5. **AAV RIGGING AND LAUNCH PROCEDURES**

WARNING

The AAV launch procedure is potentially hazardous to crewmembers, the vehicle, and the craft. Safety of crews, vehicles, and craft shall be a paramount consideration when conducting this operation.

During the conduct of an AAV launch, the following safety actions shall be implemented.

- a. The TWO-MAN rule shall be strictly enforced.
- b. All men working in the launch detail shall have positive communications with the craft Control Station.
- c. All men working on the cargo deck shall remain outside of FOD screens until the main engines on the side concerned are shut down.
- d. All men working on deck shall be in life jackets and have eye and ear protection.
- e. The operation shall be conducted only in a SWH of .5 to 1 foot or less.



During all phases of this operation, extreme care must be taken to secure all AAV equipment and antennas to prevent possible FOD ingestion by the craft.

When launching the AAV at sea, only the stern ramp shall be employed. The ramp is provided with extra support and the AAV shall be loaded facing aft. All external vehicle equipment will be secured prior to loading on the LCAC. The stern ramp support chains shall be rigged prior to LCAC departure.

When conducting the AAV launch operation, the LCAC crew shall be augmented to a minimum of 7 crewmembers in order to comply with the TWO-MAN rule. The craft Loadmaster supervises the deck launch crew, two additional qualified crewmembers man the lizard lines. The safety observer is stationed forward of the others in a position to observe all members of the launch crew.

Movement of AAV on the stern ramp is a precise evolution. The AAV must proceed onto the ramp slowly to prevent shock loading of the ramp support chains and to preclude damage to the ramp cable and hoist mechanism. After the AAV is properly positioned on the ramp, the launch order is the Loadmaster's hand signal to button up the AAV driver's hatch. After the hatch is secured, the AAV will move off the ramp rapidly but will not engage water jets until at least 50 meters from LCAC stern.

Since the stern ramp is a lightweight box structure, the unloaded ramp floats when lowered onto water surface. Because of this, all available additional ramp cable must first be pulled out of the cable pedestal prior to positioning the AAV onto the ramp. This will ensure that only the stern ramp support chains are supporting the AAV on the ramp. When supported by the chain, the ramp is inclined 20 degrees down from horizontal.

5-5.1. AAV Prelaunch Rigging When rigging for AAV launch, the stern ramp shall be supported at both ends with equal length chains to ensure an even strain. The Loadmaster is responsible for rigging the ramp prior to the start of the mission, preferable with the craft positioned on docking blocks. This allows the full range of ramp travel and provides a complete check of the fully rigged ramp. The ramp may be left rigged for several days, but a premission check of the rig and support chains are required. Equipment required: two 5/8-inch chains, each 15 feet 7 inches long; four 1-inch shackles with screw pins; and two 21-thread lines, each approximately 40 feet long.

5-5.2. AAV Launch Rigging Procedures

- a. Fly over docking blocks and secure craft (optional).

- b. Assembly required material, ensuring chains are the same length.
- c. Lower stern ramp to horizontal position, at approximately 90 percent travel.
- d. Lead chains around the hinged chain support, inboard to outboard and back to the lower padeyes on each side.
- e. Using 1-inch shackles, attach one end of each chain to uppermost padeye outboard of ramp (approximately 8 feet from the ramp hinge).
- f. Using 1-inch shackles, attach remaining end of each chain to lower padeye.
- g. Lead lizard lines (21-thread) around T-bit and out through the stern chock to the chain.
- h. Reeve each lizard line through a link of the outboard chain approximately midway between the hinged chain support and the ramp padeyes. Bend lines to inboard chains.
- i. Clear all personnel and lower ramp until chain takes full weight of ramp. Pull ramp cable slack.
- j. Check tension on each chain.
- k. While manning lizard lines to maintain a steady strain, raise the ramp. Chains should end up outboard of the ramp on each side of the ramp.
- l. Secure ends of lizard lines to the T-bit, ensuring no loose ends longer than 1 foot.
- m. Check chain on each side to ensure that slacked chain does not foul the rudder or impact the shroud.
- n. Police area for FOD.

5-5.3. AAV Launch Procedures

NOTE

AAV maneuvering for loading and offloading will require communication between the AAV driver and the Loadmaster. Standard Navy hand signals shall be used to direct the AAV driver to and from a stowage position. Figure 4-24 illustrates the AAV maneuvering hand signals to be used. All AAV drivers and Loadmaster must be familiar with the correct hand signals.

- a. Bring craft hullborne and cease forward progress.
- b. Don life jackets.
- c. Send launching party on deck and establish communications (ICS and/or MOMS).
- d. With lizard lines released and manned, lower stern ramp.
- e. Secure ends of lizard lines to T-bit, ensuring no loose ends longer than 1 foot.
- f. When directed by Craftmaster, remove tiedowns from AAV.
- g. Ensure all tiedowns are clear.
- h. Clear launching party from deck, except for Loadmaster, Deck Engineering, Linehandler(s), Safety Observer and crewman in AAV.
- i. Loadmaster direct AAV to launch position.
- j. Get underway with a speed of approximately 3 knots.

- k. When directed by Craftmaster, launch AAV.
- l. Inspect ramp and chains.
- m. Repeat Steps i., j. and k. for other AAV.
- n. When launch is complete, raise stern ramp.
- o. Secure lines and chains, and police area for FOD.

5-5.4. **Ramp Retraction** Prior to ramp retraction, LCAC will cease forward progress. The stern ramp will then be raised in accordance with Steps .k., l. and m.. of prelaunch rigging procedure (Paragraph 5-5.2.).

Life jackets must be worn by all personnel working on deck when the stern ramp is down.

5-6. **OPERATIONS WITH COMBAT RUBBER RAIDING CRAFT (CRRC)**

LCAC has proven to be a highly effective platform for combat rubber raiding craft (CRRC) insertions and recoveries. The unique physical characteristics of CRRC mandate special underway securing procedures. CRRC shall be secured to the cargo deck with four Class 2 aircraft cargo tiedowns (CGU-1/B Class 2). Tiedowns will be secured to the cargo deck by the LCAC tiedown deck fitting assembly. Stern ramp chains will be rigged prior to LCAC departure for CRRC launch, see Paragraph 5-5.1..

CRRC support equipment will be stowed as followed:

- a. Outboard motor (stowed on CRRQ)
- b. Fuel tank/bladder (secured in CRRQ)
- c. Packs with personnel (Port and STBD cabins)
- d. Weapons with personnel (Port and STBD cabins)

The craft Loadmaster will directly supervise all topside evolutions. CRRC Launch or Recovery will only be conducted as sea conditions permit. Craft crewmembers on deck will wear life jackets and double hearing protection. Positive communication will be maintained between cargo deck and starboard cabin at all times with the TWO-MAN rule being strictly adhered to. A dedicated safety observer, usually the craft Navigator will position himself forward on the cargo deck where he can best observe all deck evolutions. As this evolution takes place with propellers turning, only those personnel actually involved with launch/recovery operations will proceed aft of frame 15.

5-6.1. **CRRC Launch Procedures**

- a. Bring craft off cushion.
- b. Maneuver craft as necessary to maintain bow into seas (1-2) knots.
- c. Establish positive (TWO WAY) communications between cargo deck and STBD cabin via ICVS with MOMS as a backup.
- d. Post safety observer.
- e. Lower stern ramp into water and slack cable completely.

- f. Direct crew of first CRRC to be launched to ungripe CRRC. Loadmaster verify all grips/tiedowns are stowed.
- g. Position CRRC far enough aft on stern ramp of LCAC for outboard engine to be mounted and load equipment. Loadmaster will man bowline of CRRC to maintain positive control of craft.
- h. Launch CRRC at Craftmaster's command. Cast off line when signalled by CRRC crew.
- i. Repeat Steps f., g., and h. for remaining CRRC.

5-6.2. CRRC Recovery Procedures

- a. Bring craft off cushion.
- b. Maneuver craft bow into seas (1-2) knots.
- c. Establish positive (TWO WAY) comms between cargo deck and STBD cabin via ICVS with MOMS as a backup.
- d. Post safety observer.
- e. Lower stern ramp to waters edge.
- f. Recover first CRRC.
- g. Position CRRC forward on cargo deck. Offload/restow equipment.
- h. Repeat Steps f., g., and h. for remaining CRRC.
- i. Grip down CRRC. Unnecessary crew members clear deck.
- j. Conduct FOD walkdown.

5-6.3. CRRC Operations Safety Launch or recovery operations will be conducted in SWH of 3.5 to 5 feet or less. Craft crewmembers on deck will wear life jackets; and double hearing protection. SEAL/RECON team members will wear double hearing protection.

5-7. RIGID HULL INFLATABLE BOAT (RIB)

RIB launch and recovery is a unique and potentially hazardous evolution. A maximum of two RIB with prime movers can be launched/recovered with LCAC. Trailer-mounted RIB shall be loaded on LCAC by crane or monorail system. Damage to the RIB outdrive is possible if trailer-mounted RIB are towed on or off an LCAC by a prime mover. Once on deck the RIB are maneuvered on the LCAC deck by the prime mover.



RIB launch and/or recovery should be conducted in SWH of 0.5 to 1 foot or below to best avoid damage to RIB and/or LCAC ramp.

The LCAC loadmaster will directly supervise all deck evolutions. When launching from the stern ramp (preferred method), stern ramp chains will be rigged prior to LCAC departure.

PROCEDURE

- a. Bring craft off-cushion.
- b. Secure main engines.
- c. Establish communications between cargo deck and starboard cabin.
- d. Remove ramp deck plugs.
- e. Lower ramp into water and slacken ramp cable(s) completely to flood ramp.
- f. Ungripe RIB trailer.

WARNING

To prevent the prime mover and trailer from rolling off ramp in the event of brake failure, use safety gripes by ensuring at least two craft gripes are positioned and repositioned as prime mover is maneuvering on craft.

- g. Using safety gripes, back trailer down ramp. Rest the rear set of trailer wheels as close as possible to the seaward edge of ramp.
- h. Securely gripe prime mover.
- i. Prepare RIB for launch/recovery.
- j. Launch/recover RIB at craftmaster's command.
- k. Using safety gripes, reposition prime mover and trailer on LCAC deck and regripe.
- l. Raise ramp and secure from evolution.

- m. At the completion of mission, flush ramp through ramp deck plugs with fresh water at least three times.
 - 1. With ramp in the down position fill with fresh water.
 - 2. Drain by raising ramp.
 - 3. Repeat steps 1. and 2..
 - 4. Install ramp plugs.

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APPENDIX A

TECHNICAL MANUAL DEFICIENCY/EVALUATION REPORT (TMDER)

Ships, training activities, supply points, depots, naval shipyards, and Supervisors of Shipbuilding (SUPSHIPS) are requested to provide the maximum practical use and evaluation of NAVSEA technical manuals. Errors, omissions, discrepancies, and suggestions for improvement to SEAOPS manuals shall be reported to the Program Executive Officer, Expeditionary Warfare, Code PMS 377J, 2531 Jefferson Davis Highway, Arlington, VA 22242-5171, on NAVSEA Technical Manual Deficiency/Evaluation Report (TMDER), NAVSEA Form 4160/1. To facilitate such reporting, complete and mail NAVSEA Form 4160/1, Figure A-1. Feedback comments will be processed as directed in the SEAOPS Manual Feedback System (see Foreword).

Ref: NAVSEAINST 4160.3A

(Insert Classification of TMDER Here) CLASSIFICATION:

NAVSEA S0005-AA-GYD-030/TMMP

NAVSEA/SPAWAR TECHNICAL MANUAL DEFICIENCY/EVALUATION REPORT (TMDER)				
INSTRUCTION: Continue on 8 1/2" x 11" paper if additional space is needed.				
1. USE THIS REPORT TO INDICATE DEFICIENCIES, PROBLEMS, AND RECOMMENDATIONS RELATING TO PUBLICATION. 2. FOR CLASSIFIED TMDERS. SEE OPNAVINST 5510H FOR MAILING CLASSIFIED TMDERS.				
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5. TITLE			6. REPORT CONTROL NUMBER	
7. RECOMMENDED CHANGES TO PUBLICATION				
PAGE NO. A.	PARA- GRAPH B.	C. RECOMMENDED CHANGES AND REASONS		
8. ORIGINATOR'S NAME AND WORK CENTER (Please Print)		9. DATE	10. DSN/COMM NO.	11. TRANSMITTED TO
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Figure A-1 (TMDER) Evaluation Report Form (Sheet 1 of 2)

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Figure A-1 (TMDER) Evaluation Report Form (Sheet 2 of 2)

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